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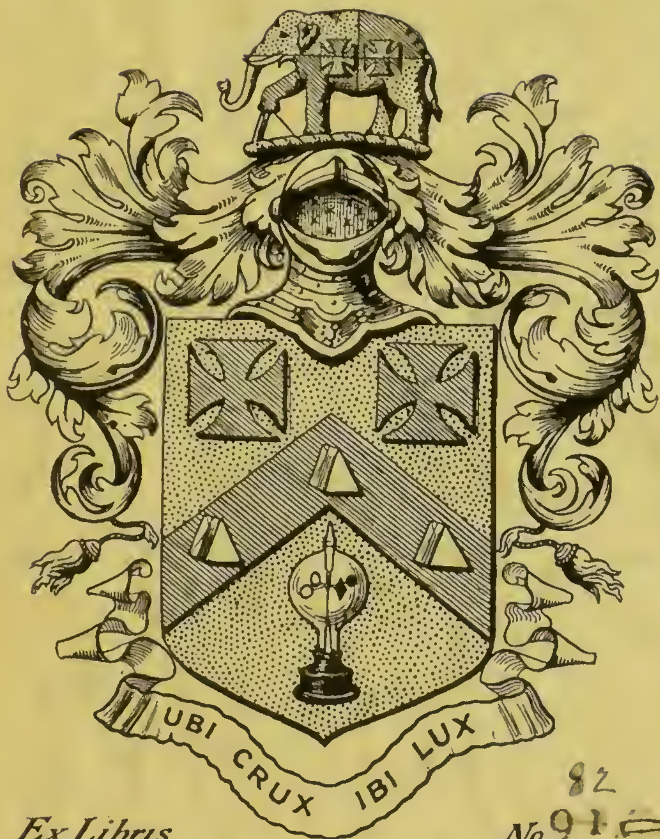
Odorographia: A Natural History of Raw Materials and Drugs Used in the Perfume Industry, including the Aromatics Used in Flavouring. Intended for the Use of Growers, Manufacturers, and Consumers. By J. CH. SAWER, F.L.S. Second Series. London: Gurney and Jackson (successors to Mr. Van Voorst). Brighton: W. J. Smith. 1894. 8vo, pp. 523.

SOME time ago we had the pleasure of examining and noticing the first series of this valuable and interesting work, and we now welcome the second volume. Hitherto perfumes have in English scientific and technical literature enjoyed a share of attention remarkably small either from a chemical or a biological point of view, or as regards the extensive trade of which they form the subject. The misfortune is that as yet we are unable to define perfumes as distinct from evil odours. It is probable that some of the substances included in the present work would be relegated by many persons to the latter class. We need merely mention buchu, chamomile, fennel, and tansy. We may remark that the function of the pleasant odours given off by so many plants has been determined. But why the stench-worts—if we may be permitted so to call them—have been endowed with their offensive smells is still an unsolved problem. Their disagreeable emanations do not appear to keep off any enemies.

Turning to a very different subject we notice that the sophistication of essential oils is carried on with great diligence and skill, whilst the tests for recognising its purity are not to be depended upon under all circumstances. English oil of peppermint is so largely mixed with the American and Japanese products that it can be no longer recognised. It is to be feared that the manufacturers and merchants often work under the advice of able chemists. These gentlemen may, in apology, plead the example of eminent counsel whose conscience permits them to hold briefs for men whom they know to be quacks of the most dangerous grade.

Mr. Sawer, in his list of errata, refers to, and in a way half apologises for having in his first series spoken of "coker" nuts. He tells us that this kakography is used by the large fruit importers of London. Unfortunately, many people in London take unwarrantable liberties with the letter *r*, omitting it where it ought to be used, and inserting it where it has no right to be present. Unfortunately, also, three important vegetable products have their names habitually confounded in "English as she is spoke": the cocoa-nut, the fruit of *Cocos nucifera*, the chocolate-nut or bean, the product of the orchid *Theobroma cacao*, and the coca or cuca of South America, yielded by *Erythroxylon coca*. Perhaps to get rid of this confusion it might be well to call the first-mentioned fruit *ocos*-nut, retaining its botanical name.

Mr. Sawer's valuable, elaborate, and trustworthy compilation will be of immense value to the interests whom it more especially concerns. We hope that it may have the effect of encouraging planters to take up more systematically the production of the perfume plants, and … omising industry.



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SIR WILLIAM CROOKES, D.Sc., F.R.S.

ODOROGRAPHIA.

A NATURAL HISTORY

OF

RAW MATERIALS AND DRUGS

USED IN THE

PERFUME INDUSTRY

INCLUDING

THE AROMATICS USED IN FLAVOURING.

INTENDED FOR THE USE OF
GROWERS, MANUFACTURERS, AND CONSUMERS.

BY

J. Ch. SAWER, F.L.S.

SECOND SERIES.

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PREFACE.

ENCOURAGED by the reception given to the First Volume of this handbook (referred to as the 1st Series), the author, as suggested in his preface thereto, now issues a Second, which, in continuation of the subjects already discussed, includes a concise description of certain spices and products used as flavouring materials.

The information contained in the First Volume is now as far as possible brought up to date; the continued labours of chemists, especially in Germany and France, requiring such additional information to be recorded.

Special sections are devoted to the consideration of Empyreumatic Oils and Ferment Oils, subjects which had not hitherto received the attention they required.

The concluding sixty pages describe the botanical characters of many plants which are capable of supplying fine Floral perfumes. These descriptions may appear somewhat lengthy, but such details will be found necessary to identify the species.

English and Foreign works of reference and journals are copiously quoted from as before.

The author is greatly indebted to Messrs. Schimmel & Co., of Leipzig, for much valuable practical information, which could scarcely be obtained from any other firm of Essential Oil Distillers in the world.

BRIGHTON,

March, 1894.

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ODOROGRAPHIA.

Nutmegs and Mace.

These spices are furnished by plants of the genus *Myristica* (natural order *Myristicaceæ*), lofty trees or shrubs, mostly aromatic, and abounding in a reddish, acrid juice.

The order *Myristicaceæ* is confined to the tropics. In India none of the species are known further north than 26° N. lat., on the northern face of the Khasia hills. From America only thirteen species are described, the Indian species numbering twenty-three. The species are probably most numerous in the eastern part of the Malayan Archipelago. A few are found in tropical New Holland, but none, as far as is known, in China. From Africa no species have been described, but in the British Museum there are two specimens marked "Myristica ?"; one of these, from Cape coast, is a subscandent stipulate plant, apparently belonging to *Malvaceæ* or *Euphorbiaceæ*, but the other, brought from Sierra Leone, is in fruit and probably belongs to this order.

Most of the species possess aromatic qualities, though occasionally these are very faint, and in some instances confined to the arillus (the "Mace") or to the fleshy part of the fruit.

Several species are said to be employed in India to adulterate the true Nutmeg, and in America, one or more yield when fresh a tolerable substitute for that valuable spice, though their aromatic qualities are unfortunately not permanent.

Myristica fragrans, Houttuyn, Nat. Hist. II., part iii., page 333; Blume, "Rumphia" I., p. 180, t. 55; *M. officinalis*, Lin. fil.; Hooker, Bot. Mag., t. 2756 and 2757; Bentley and Trimen, t. 218; Nees Plant. Med., t. 133; *M. moschata*, Thunberg; *M. aromatica*, Lamarck.

It is a beautiful evergreen tree of 20 to 40 feet in height: often with a lofty undivided trunk and horizontal, more or less verticillate branches. The leaves are shining, dark, oblong-elliptic and aromatic; they are alternate, simple, entire, strongly-veined, petiolate, and devoid of stipulas. The flowers are almost invariably diæcious, very small, and clustered in the axils of the leaves. The fruit is pendulous, somewhat in the form of a small rounded pear, about 3 inches long by 2 inches wide: it has a longitudinal groove on one side like a peach, and when ripe bursts into two pieces; the enclosed single seed, covered by the false aril or arillode, which constitutes the substance known as Mace, being exposed to view. The seed itself has a thick, hard, outer shell enclosing the nucleus or Nutmeg. The nutmeg itself consists of the oleaginous albumen or perisperm, with the embryo at one end, and is covered by a thin membrane which adheres closely to its surface and projects into the substance of the albumen, thereby giving it the mottled appearance for which it is so remarkable.

The *Myristica fragrans* is an inhabitant of the Moluccas, and is especially luxurious in the Banda Isles, almost the entire surface of three of the group being devoted to the cultivation of this tree, which, when once established, requires hardly any care or attention. The volcanic nature of the soil of these islands, the deep shade and excessive humidity of the dense forests, are eminently suitable to its growth. These islands are Lontar, Pulo Ai and Pulo Nera, and are designated "The Nutmeg Islands." These islands, famous for this production, are not very large in size; the area of the largest, Lontar (or the Great Banda), being comprised in the space of seven miles long by two miles wide.

At one time the culture of nutmegs was almost entirely in the hands of the Dutch, who took every means to monopolise the growth of the plants and confine them to these three Banda isles, but their attempts were partly frustrated by a pigeon, called the "nutmeg-bird," or the "nut-eater" (a species of *Carpophaga*), which, extracting the nutmeg from its pulpy pericarp, digests the mace, but voids the nutmeg in its shell uninjured, which, falling in a suitable situation, readily germinates. It is related that the Dutch used to burn nutmegs when the crops were superabundant, in order to keep up high prices. Many interesting particulars

regarding this monopolising policy are given in Crawford's History of the Indian Archipelago, I., p. 505 ; II., p. 437 ; and III., p. 406.

The tree is found wild on the islands of Jilolo, Ceram, Amboina, Bouro, in the western peninsula of New Guinea and the adjacent islands, including the small volcanic group situated to the south of Ceram, but it is not indigenous to islands further westward or to the Philippine islands. It has been successfully introduced at Bencoolen, on the west coast of Sumatra; at Malacca, the islands of Ternate and Menado in the Celebes group: Java, Penang, Singapore, Bourbon, Zanzibar, and some of the West Indian Islands, also into Bengal and into Brazil. Many large plantations (called Nutmeg Parks) are established, but the cultivation has only proved successful in a few of the localities into which it has been introduced.

In its native habitat the tree commences to bear fruit when between seven and nine years old, and continues to yield a crop for sixty and even eighty years: the annual yield of each female tree being about 2000 nuts. It is considered that one male tree is sufficient for the fertilization of twenty female trees.

In "Journal of the Indian Archipelago," V., p. 78 the cultivation of Nutmegs in Bencoolen, Sumatra, is described as follows :—"The mode of culture adopted in the different nutmeg plantations is nearly the same. The beds of the trees are kept free from grass and noxious weeds by the hoe, and the plough is occasionally run along the interjacent spaces for the purpose of eradicating the Lallang *(Andropogon caricosum)* which proves greatly obstructive to the operations of agriculture. The trees are generally manured with cow-dung and burnt earth once a year in the rainy season. The pruning knife is too sparingly used; very few of the planters lop off the lower verticals of the trees or thin them of the unproductive and straggling branches.

The site of a plantation is an object of primary importance, doubtless the alluvial grounds are entitled to preference from the acknowledged fertility of their soil, and its appropriate organization and capacity for retaining moisture. Several of the nutmeg trees of the importation of 1798 at Moco Moco are in soil of this description; although never manured they are in the highest state of luxuriance and bear abundantly. . . . Next to the alluvial deposits, virgin forest lands claim pre-eminence, their surface

being clothed with a dark-coloured carbonized mould formed by the slow decay of falling leaves and mouldering trunks of trees, and next to these are to be ranked the open plains. Declivities are objectionable from the risk of the precipitation of the mould and manure into the adjacent ravines by the heavy torrents of rain that occasionally deluge the country. Above all, the plantation must be protected from the southerly and northerly winds by a skirting of lofty trees, and if nature has not already made this provision, no time should be lost in belting the grounds with a double row of the *Cassuarina littorea* and *Cerbera maughas*, which are well adapted for this purpose. This precautionary measure will not only secure the planter against eventual loss from the falling off of the blossom and young fruit in heavy gales, but will prevent the up-rooting of the trees, a contingency to which they are liable from the slender hold their roots have in the soil. If the plantation is extensive, subsidiary rows of these trees may be planted at convenient distances. No large trees whatever should be suffered to grow among the spice trees, for these exclude the vivifying rays of the sun and arrest the descent of the salutary night dews, both of which are essential to the quality and quantity of the produce. They further rob the soil of its fecundity and intermingle their roots with those of the spice trees. It is true that by the protection they afford they prevent frequently the premature bursting of the husk, occasioned by the sudden action of a hot sun upon it when saturated with rain, but the loss sustained in this way is not equal to the damage the spice trees suffer from these intruders.

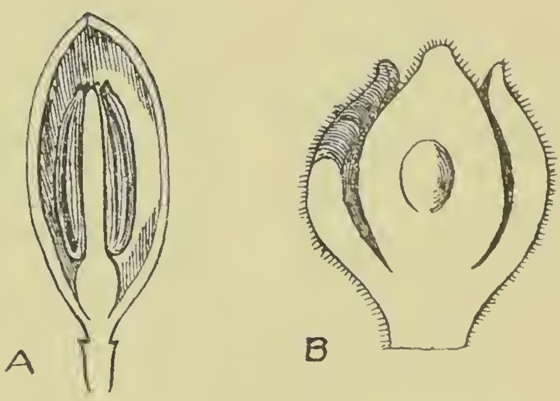
In originating a nutmeg plantation, the first care of the cultivator is to select *ripe* nuts, and to set them at the distance of a foot apart in a rich soil, merely covering them very lightly with mould. They are to be protected from the heat of the sun, watered in dry weather every other day, and occasionally weeded. The seedlings may be expected to appear in from thirty to sixty days, and when four feet high, the healthiest and most luxuriant, consisting of three or four verticels, are to be removed at the commencement of the rains, to the plantation, previously cleared of trees and underwood by burning and grubbing up their roots, and placed in holes dug for their reception at the distance of eighty feet from each other, screening them from the heat of the sun and violence of the winds. It is a matter of essential

importance that the ground is well opened and its cohesion broken, in order to admit of the free expansion of the roots of the tender plants, and that it be intimately mixed with burnt earth and cow-manure, in the proportion of two-thirds of the former to one-third of the latter. The plants are to be set in rows, as well for the sake of regularity, as for the more convenient traversing of the plough, which is now to be employed in clearing the intermediate spaces of Lallang and other noxious grasses, carefully avoiding to trespass on the beds of the trees. They must be watered every other day in sultry weather, manured annually during the rains with four garden baskets full of the above-mentioned compost to each tree, and protected from the sun until they attain the age of five years. They will now be sufficiently hardy to bear the sun, and from that age until their fifteenth year the compost should consist of equal parts of cow-dung and burnt earth, and from eight to twelve baskets full will be required for each bearing tree, a lesser proportion being distributed to the males. From the power of habit, the trees will, after the fifteenth year, require a more stimulating nutriment; the dung ought not, therefore, to be more than two or three months old, and the mixture should consist of two parts of it to one of burnt earth, of which the suitable proportion will be from twelve to sixteen baskets to each tree biennially. In all cases the prepared compost must be spread out in the sun for three or four days previous to its application, in order to destroy grubs and worms that may have lodged in it, and which might injure the roots of the plants. In all plantations, whether situated in forest land, or in the plains, the necessity of manuring at stated intervals has been found indispensable, and is indeed identified with their prosperity. The proper mode of applying it is in a circular furrow in immediate contact with the extremities of the fibrous roots, which may be called the absorbants of the plant. Where there is a scarcity of dung, recourse may be had to the dregs remaining after the preparation of the oil from the fruit of the *Archis hypogæa*, which in mixture with burnt earth is a very stimulating manure, or composts may be formed from the decomposition of leaves or vegetable matter of any description. A very fertilizing and highly animalized liquid nutriment for plants is obtained by macerating human ordure in water in proper pits for four or five months, and applying the fluid to the radical absorbents of the plants. Seaweed and many other

articles may also be resorted to which will readily occur to the intelligent agriculturist.

During the progressive growth of the plantation, the beds of the trees are to be regularly weeded and the roots kept properly covered with the mould, for these have a constant tendency to seek the surface, the growth of the lateral branches alone is to be encouraged, and all suckers and dead or unproductive branches are to be removed by the pruning-knife, so as to thin the trees considerably, and to admit of the descent of the night dews, which are greatly contributive to their well-being, especially during the dry and sultry weather; creepers are to be dislodged and the lower verticels lopped off, with a view of establishing an unimpeded circulation of air. The fittest time for pruning the trees is at the conclusion of the great harvest. After the eradication of the Lallang, the growth of innoxious grasses is to be encouraged in the spaces between the trees, which will give the plantation the appearance of a park, and the plough is now to be abandoned.

The nutmeg-tree is monœcious as well as diœcious, but no means of discovering the sexes before the period of inflorescence



A.—Vertical section of male flower.
B.—Ditto of female flower.

are known. The relative proportion of male and female trees to each other is also undefined, and is indeed the result of chance,

but the number of productive trees may be roughly estimated at two-thirds of the whole cultivation. The number of male trees necessary to be retained will depend entirely on that of the female kind; all above this number, being considered superfluous, should be cut down, and other trees planted in their stead." The writer on whose authority this description is given remarks:—"Were I to originate a nutmeg plantation, I should either attempt to procure grafts of male stocks on such trees as produce the largest and best fruit by the process of inarching, notwithstanding the speculative hypothesis of the graft partaking of the gradual and progressive decay of the parent tree, leaving a branch or two of the stock for the purpose of establishing a regular polygamy, by which means the plantation would consist of monœcious trees only; or I should place the young plants in the nursery at the distance of four feet from each other, and force them to an early discovery of their sex, by lifting them out of their beds once a year and replacing them in the same spot, so as to check the growth of wood and viviparous branches. The sex might be thus ascertained on an average within the fourth year, and the trees removed to the plantation and systematically arranged, whereas in the usual mode of proceeding it is not generally ascertainable before the seventh year."

Upon an average the nutmeg tree fruits at the age of seven years, and increases in produce till the fifteenth year, when it is at its greatest productiveness. It is said to continue prolific for seventy or eighty years in the Moluccas. Seven months in general elapse between the appearance of the blossom and the ripening of the fruit, and the average produce, under good cultivation, may, in the fifteenth year of the plantation, be calculated at five pounds of nutmegs and a pound and a quarter of mace. It is remarked, however, that some trees produce every year a great quantity of fruit, whilst others constantly give very little. It bears all the year round, but more plentifully in some months than in others. The great harvest may generally be looked for in the months of September, October, November and December, and a small one in April, May and June. Like other fruit trees on this portion of Sumatra, it yields most abundantly every other year. The fruit having ripened, the outer integument bursts spontaneously, and is gathered by means of a hook attached to a long stick, and the mace being cautiously stripped off and

flattened by the hands in single layers, is placed on mats for three or four days in the sun to dry. Some planters cut off the heels, and dry the mace in double blades from an opinion that the insect attacking the spice is apt to build in or about the heels, and that the double blade gives a better and more substantial appearance to the mace. The former idea is entirely groundless, for if the article be properly cured, kept in tight packages in a dry situation, and exposed to the sun for five or six hours once a fortnight, there need be no apprehension of the insect; and if it is not, it will assuredly be attacked by it, whether the heels be cut off or not. Again, the insect is much more likely to nestle within the fold of the double blade, and the fancied superiority of appearance has so little weight with the purchaser, as not to counterbalance the risk of probable deterioration and eventual loss. In damp and rainy weather the mace should be dried by the heat of a charcoal fire, carefully conducted so as not to smoke or blacken its surface.

The nuts liberated from their macy envelope are transported to the drying-house and deposited on the elevated stage of split neebongs, forming hurdles or gratings, placed at a sufficient distance from each other to admit of the heat from a smouldering fire beneath, without suffering even the smallest nuts to pass through. The heat should not exceed 140° Fahrenheit, for a sudden inordinate degree of heat dries up the kernels of the nuts too rapidly, and its continued application produces fissures in them, or a fermentation is excited in them which increases their volume so greatly as to fill up the whole cavity of the shell, and to prevent them from rattling when put to this criterion of due preparation. The fire is lighted in the night. The smoking-house is a brick building of a suitable size with a terraced roof, and the stage is placed at an elevation of ten feet from the ground, having three divisions in it for the produce of different months. The nuts must be turned every second or third day, that they may all partake equally of the heat, and such as have undergone the smoking process for the period of two complete months, and rattle freely in their shell, are to be cracked with wooden mallets, the worm-eaten and shrivelled ones thrown out, and the good ones rubbed over simply with recently-prepared well-sifted dry lime. They are now to be re-garbled and finally packed for transportation in tight casks, the insides of which have been smoked, cleaned and covered with a coating of lime mixed with fresh water. If

packed in chests, the seams must be caulked to prevent the admission of air or water. There is no necessity for sorting them, as previously to their sale they are cast into sizes in London. The mode frequently practised in preparing nutmegs for the market is to crack them and dip the kernels in a mixture of salt-water and lime, and to spread them out on mats for four or five days in the shade to dry. Thus prepared, they are termed "limed nutmegs," and in some countries they are preferred. The lime is said to preserve the seeds from insects, but it injures the flavour. (The Chinese wisely prefer to import their nutmegs in the testa, or shell, in which they keep good for a great length of time: the shells constitute one third of the total weight). The process of "liming" was resorted to for the purpose of preventing the germination of the nuts after being shipped to their destination; but it has been proved that this process is perfectly unnecessary, and that a simple exposure of the nuts to the action of the sun for a week is sufficient to destroy the vitality of the embryo. Immersion in milk of lime destroys many of the nuts; a second process of desiccation is also necessary. The inutility of the process has been further demonstrated by Lumsdaine* in the following words:—"I am convinced from much experience that this is a pernicious practice, not only from the quantity of moisture imbibed in this process, encouraging the breeding of insects and rendering the nuts liable to early decay, but from the heating quality of the mixture, producing fissures and occasioning great loss in the out-turn (ultimate weight): whereas by limiting them simply in the dry way in the way I have recommended (above), the loss ought not to exceed eight per cent. In May I made some experiments on this subject: I cracked a quantity of nutmegs that had been smoke-dried for two months, and distributed them into four equal portions. I prepared the nuts of one parcel with a mixture of lime and salt-water: those of the second were rubbed over merely with fine-sifted well-dried shell-lime, such as the natives use with their betel, although I have no doubt but that recently-prepared and well-sifted common lime would answer equally well: those of the third parcel were mixed, unlimed, with one-third of their weight of whole black pepper: and those of the fourth, also unlimed, with the same proportion of cloves. They were then put

* Journal of the Indian Archipelago, V., p. 78.

into separate boxes with sliding tops and numbered 1, 2, 3 and 4, in the order I have mentioned them. At the expiration of the first year they were all sound. After that of the second, I found three worm-eaten nuts in No. 1, and two in No. 3, but those in Nos. 2 and 4 remained untouched The injured nuts were allowed to remain, and after the lapse of the third year five worm-eaten ones were discovered in No. 1, three in No. 3, and two in No. 4: those in No. 2 being in their original state. Upon examining the several boxes of nuts after a lapse of four years and four months from the commencement of the experiments, the number of decayed nuts in Nos. 1, 3 and 4 had not increased, and the nuts in No. 2 were as good as they were on the day they were put into the box. These experiments not only prove the superiority of liming in the dry way, but also the fact that the progress to general decay in a heap of nutmegs, even after the insect has established itself, must be a work of years."

The custom of "liming" nutmegs by the "wet" method is, however, still much in use, and the predilection in favour of the spice so prepared, is so strong in certain countries, that nutmegs exported from their native place in the unlimed condition are frequently limed in London to suit the markets of the countries to which they are ultimately destined. Penang nutmegs are always shipped from that place in their natural condition,—unlimed. The unlimed, or "brown nutmegs" (sometimes mixed with cloves, as in experiment No. 4 above quoted) are highly esteemed in England, and even preferred by some to the limed produce; most probably from the greater facility of detecting the flaws in them in their naked state.

Nutmeg Cultivation in Jamaica. In the "Bulletin of the Botanical Department of Jamaica" for October, 1891,* it is stated that "a large stock of the very finest nutmegs for seed has been imported to Jamaica from Grenada, and has been sown in the Hope Gardens, and when ready for distribution will be sold at the very low rate of three half-pence each, in large or small quantities. It is hoped that these arrangements will tend to develop the planting of nutmegs on a large scale in suitable districts in Jamaica. . . . . The germination of the seed in large quantities and the care of the seedlings, is said to require the strictest attention to prevent extensive loss. From the seed-bed, the seedlings are

*Abstracted into Pharm. Journ. [3] xxii., 656.

transferred to bamboo pots. and, when they have quite recovered from the transplanting, and have formed good roots, they are ready for the nutmeg plantation. The planters must now exercise strict supervision over the labourers to see that the bamboo pot is carefully slit down on one side, and the plant, with the earth undisturbed round the root, gently placed in the hole prepared for its reception. If this operation is done too harshly or clumsily, the tip of the tap root is broken and the plant soon dies.

Nutmeg trees require a deep, rich, loamy soil, moist, but not swampy, with a humid atmosphere. They thrive best in steady river valleys from the sea-level up to 300 or 400 feet, but they will grow in favorable situations up to an elevation of 2,000 feet. The trees should be placed at distances of 25 or 30 feet apart, and if the situation is not naturally shady and sheltered, trees should be planted for the purpose of breaking the wind as well as to provide shade to the young plants. The trees are a long time coming to maturity, not producing a crop, as a rule, till they are nine years old; and only when they first flower, at six or seven years of age, is it possible to determine whether they are male or female. A very small proportion of male trees is left for fertilization by insects; the rest are cut down, and fresh plants are substituted. The fertile trees continue to produce fruit for seventy or eighty years. On an average, each tree will yield ten pounds of nutmegs and about one pound of mace every year; and, when highly manured, it is said that they will produce ten times that amount."

A note on the curing of nutmegs in Grenada is given in the November, 1891, number of the "Jamaica Bulletin," the details of which may be of service to those who are starting the culture. The process is said to be that which is adopted for preparing the nutmegs for the London market. The nutmegs are picked up from under the trees every day (except Sunday). On being brought into the "boucan," the mace is peeled off and pressed flat between heavy blocks of wood, where it is left for two or three days, then put into a case and left till it reaches the proper colour. The nutmegs are put into receptacles with fine mesh bottoms, so that the air can pass through, and left inside the "boucan" for three weeks or a month, in fact until the nut begins to shake inside the shell; they are then placed in the sun for a couple of hours a day for two or three days. After this they are cracked. Great care is necessary here, for if the outside shell is struck too

hard, it makes a black spot on the nutmeg, which affects the value considerably. When cracked, the nuts are sorted according to size, put into ordinary flour-barrels and shipped. Regarding the value of the produce of nutmeg trees when in full bearing, it is stated, that one grower in 1883 realized from two trees as much as £30.

The "Report of the Jamaica collection of products at the International Exhibition at Philadelphia, 1876," states that "The nutmegs exhibited by Jamaica were not equal in point of value to the remarkably large and fine specimens shewn by several other countries. The value of nutmegs depends upon size,—the larger the size, the greater the value."

The dried produce of a nutmeg tree consists of nutmeg, mace and shell in the following proportions :—In 15 parts of the whole produce there are two parts of mace, 5 of shell and 8 of nutmegs. Hence, although nutmegs in the shell keep better than the clean or shelled nutmegs, yet the heavy allowance required for the shell (viz., about one-third) is a serious objection to their preservation in this form.

In commerce, two kinds of nutmegs are met with : the "round nutmegs," and the "long" or wild nutmegs.

The "true" *round or "female" nutmeg, Nux myristica fœmina,* Clusius (*Nux muschata fructo rotundo,* C. Bauh.), is the produce of *Myristica fragrans.* It is about an inch in length, its shape is roundish or elliptical, like that of the French olive; externally it is marked with reticulated furrows. The colour of the "unlimed" or "brown" nutmeg is ashy-brown; that of the "limed" nutmeg is brown on the projecting parts, and white (from the presence of lime) in the depressions. Internally, nutmegs are pale reddish-grey, with red veins. Occasionally the round nutmeg is imported in the shell. This is dark and shiny.

A very small nutmeg, not larger than a pea, is mentioned by Pereira* under the name of "Royal Nutmeg" (*nux moschata regia*).

Penang Nutmegs are unlimed, or brown nutmegs, and fetch the highest price. They are sometimes limed in London for exportation to continental markets where that description is preferred.

*Mat. Med. II., Pt. i., p. 473.

Dutch or Batavian Nutmegs are limed and are lower in value than the Penang sort.

Singapore Nutmegs are a rougher, unlimed narrower sort, of somewhat less value than the Dutch.

"Long" or "Wild Nutmegs," or "Male" nutmeg, *Nux myristicamas*, Clusius (*Nux moschata fructu oblongo*, C. Bauhin), is the produce of *Myristica fatua*, Houttuyn. The oldest works making mention of the nutmeg speak of several kinds which must have attracted the attention of the earliest Dutch settlers. In 1596, before the conquest of Banda, Linshchoten mentioned two kinds of nutmeg—"round" and "long"; and in 1605 Clusius gave drawings of a fruit branch of *Nux myristica-mas*, as well as the ordinary nutmeg. In several of the older drawings of Piso and Valentini the leaves of the true nutmeg are incorrectly associated with the fruit of this second variety. However, it is on the whole clear what is meant, and there is no doubt that all these remarks apply to the *Myristica fatua*, Houtt., a tree which certainly grows wild in Banda and Amboyna; perhaps, also, in other of the Molucca islands. Its fruit is scarcely at all aromatic when fresh, and less so in the dry state, while its mace smells disagreeable and not aromatic. The fruit is therefore only used medicinally in that island for dysentery, headache, or as an aphrodisiac.

The fruit is elongated, ellipsoidal, rusty, tomentose; in shape it is like a date and about 1½ inches to 2 inches in length. The shell is hard and somewhat brittle; internally of a dull greyish-white. The seed is elongated, ellipsoidal, covered by a membranaceo-fleshy, orange-coloured, insipid arillode (mace); outer coat (testa) dark-brown, hard; nucleus acerb, slightly aromatic, greyish ash-coloured, cylindrical, ellipsoidal, rugous, marked with a furrow.

Malabar Nutmegs are the produce of *M. Malabarica*, Lamk.; Bedd. Fl. Sylv. t. 269: Rheede Hort. Mal. iv., t. 5 (Rheede calls it Panam-pálca). Its nucleus resembles a date in size and shape. It is very closely allied to the "Long nutmeg" (*M. fatua*), Houtt., and has comparatively little flavour or odour, even less than the long nutmeg, with which it is frequently mixed as an adulterant; in fact, both these nutmegs are mixed with true nutmegs (*M. fragrans*), and their mace with true mace, selling

them together. An oil is also extracted from these inferior articles and used to adulterate the genuine oil.

New Guinea Nutmegs.—As the intercourse between the Moluccas and New Guinea increased, an entirely new kind of nutmeg came into the hands of Europeans, viz., the *Myristica argentea*, Warb., that was probably first noticed in 1666. Since the Middle of the 18th century it became an article of commerce in Eastern Asia. Towards the end of that century it was first brought to Europe, and at the present time it is the most important article of export from New Guinea. Nevertheless this nutmeg remained undescribed and unknown, as well as the plant which produces it. Dr. Warburg succeeded in obtaining information on this point through the assistance of a native, who was persuaded to show him some of the trees in Dutch New Guinea. They were characterised by large leaves having a silvery appearance on the under side ; hence the name.

Next to *Myristica fragrans*, the *M. argentea* is certainly the most important variety, and that which has the greatest future. Its odour is not so delicate as that of the true nutmeg, but that may be due to the circumstance that it is not prepared and packed with as much care as the true kind. The export from the province of Onin is estimated by Beccari to have amounted to about 125 pounds at the middle of the 18th century, and it exceeded in importance that of all other produce. Since then, the regular service of steamers has led to a great increase in this trade. Formerly the nutmegs were sent in small parcels by ships to Banda, there treated in the same way as true nutmegs, and sometimes mixed with them. Now they are all taken direct to Macassar, where they are shelled and dusted with lime. The price of them in Macassar is about one-third that of the best quality of true nutmegs. While formerly these nutmegs were used only in the Malay Archipelago, in the Philippine Islands, &c., by the natives, probably on account of their cheapness (as *Para papua* in the Malay country, and as *Aniz moscada* in the Philippines), and came only occasionally to Holland and England, they are now regularly imported into England (1892), as "Long nutmegs," and they have been known in Germany since 1890 as "Horse nutmegs." Apart from the fact that the aroma is not so delicate, these nutmegs are also very friable, but the broken

fragments can be used for the production of essential oil. They are also very liable to be attacked by maggots, even when they have been "limed." Their aroma is very permanent even after being kept a number of years; samples dating from the previous century have still a strong smell when crushed. Hitherto the mace has not been brought into commerce. Samples of it brought to Europe have a dirty grey or red-brown colour, but this is probably due to defective drying. It is uncertain whether in drying the mace would acquire the yellow-red colour of that of *M. fragrans*, but it is certainly capable of being made useful, provided it can be properly prepared.

These nutmegs would come into actual competition with true nutmegs only in the event of their being carefully cultivated and gathered as the produce of M. fragrans is, and it is not improbable that their lower price would be compensated by a larger yield.

The nutmegs of *M. argentea* differ from true nutmegs in their narrow, long shape, and the relatively less marked arillus furrows. The arillus generally consists of four broad stripes, which are united above and below. The same with the hard shell is from 3½ to 4½ c.m. long, and from 2 to 2½ c.m. broad. It is broadest at the base, and becomes gradually narrower towards the end, externally of a bright red colour when fresh, but as met with in commerce it is generally of a yellow-brown colour. The fruit is imbedded in a very thick pericarp, and when fresh it is from 4½ to 6½ c.m. long and 4½ to 5½ c.m. broad. The testa is nearly 1 m.m. thick. The endosperm contains much starch, and the brown runcination streaks, which alone contain the aroma, are more scattered and coarser than in true nutmegs. The cotyledons are joined in a disc swelled at its edges to 5 m.m. diameter.

At a meeting of the Berlin Pharmaceutical Society, 2nd June, 1892, Dr. Warburg called attention to the species *Myristiea suceedanea*, which was discovered by Reinwardt in the island of Tidoee (one of the Moluccas) in 1821. These nutmegs can scarcely be distinguished from those of M. fragrans, and they are very aromatic. The leaves and flowers of this variety are, however, quite different from those of *M. fragrans*.

In New Guinea there is a great number of varieties of nutmeg plants, the produce of which possess some aroma, but, though permanent, it is generally too feeble to admit of these kinds being used to any extent as substitutes for true nutmegs.

The nuts of the true nutmeg (*Myristica fragrans*) are known in Hindustanee and Bengalee under the name "Jaiphal"; those of *Myristica Malabarica* as "Rán-jaiphal" and "Rámphal," and in the Malabar dialect "Panam-palka."

Mace is the laciniate envelope of the nutmeg, usually called the aril. It is said by Planchon to be nothing but an expansion of the exostome, and therefore an *arillode* or false aril.

Mace is picked off the nuts by hand and prepared for the market by drying it for some days in the sun. Some flatten it by the hands in single layers; others cut off the heels and dry the mace in double blades.* In rainy weather artificial heat is employed for drying it. At first the mace is crimson or blood red, but in process of drying it loses this tinge, and after a few months acquires the golden colour preferred by the dealers. The Dutch sprinkle the mace with salt water prior to packing it in the sacks called *sokkol.*

True or genuine mace is the produce of the round or true nutmeg. It occurs in single or double blades, flat, irregularly slit, smooth, slightly flexible or brittle membrane, of a pale cinnamon-yellow or golden-yellow colour, and an odour and taste analogous to those of nutmegs. The Penang mace is the most esteemed. It is flaky and spread. The Dutch or Batavian mace is more fleshy and scarcely fetches so high a price as the former, and the Singapore mace is considered inferior to both of them.

Wild or false mace, the produce of the Long or Wild nutmeg, is dark red in colour, of strong, coarse flavour, very different to that of the true mace.

As an adulterant of true mace the arillus of *Myristica Malabarica* Lam, known under the name of Bombay Mace, has been used during the last two centuries. It is much larger and more cylindrical than the arillus of true nutmeg, and the several flaps are united at the apex, forming a conical structure. The anatomical structure is also different, as may be seen by the aid of a microscope. When moistened with hydrochloric acid, the Bombay mace presents the marked peculiarity of assuming a greenish colour.

Oil of nutmeg, to which the flavour and odour of nutmegs are due, is obtained by distillation of the pulverised nuts. The yield

* Newbold, Political and Statistical account of the British Settlements in the Straits of Malacca, vol. i.

is from 8 to 10 per cent. The oil is straw-coloured; sp. gr. 0·93, consisting principally of a hydrocarbon $C_{10}H_{16}$, boiling at 165° C. It appears, by the researches of Dr. Wright,* that this is a mixture of at least two hydrocarbons, one a terpene boiling at 163°, the other ordinary cymene. This last was extracted by treating the mixture of hydrocarbons with sulphuric acid, whereby the terpene became resinized. On distillation with water, cymene passed over unaltered; when purified, this was found to be identical with all the other known varieties of cymene. Oil of nutmeg also contains an oxygenated constituent which Gladstone named *Myristicol*, and assigned the formula $C_{10}H_{14}O$, boiling near 212°. (Wright states that the analytical numbers of this body agree better with the formula $C_{10}H_{16}O$).

Examined by polarised light in a 200 m.m. tube, oil of nutmeg (distilled in London) was found to deviate the ray 15°·3 to the right; and oil of "long" nutmeg 28°·7 to the right.†

The results of Dragendorff's experiments respecting the solubility of oil of nutmeg in alcohol are as follows‡ (the sample *a* being obtained from Herr Zeise, as pure; the sample *b* was not distilled so recently):—

	a	*b*
1 c.c. of oil	mixed with 91 per cent. alcohol was clear in all proportions.	was almost clear in 2 c.c. of alcohol of same strength.
,,	was quite clear in 3 c.c. of 87 per cent. alcohol.	was almost clear in 7 c.c. of alcohol of same strength.
,,	was very nearly dissolved in 6 c.c. of 85 per cent. alcohol, and formed a perfectly clear solution in 8 c.c. of the same.	

The strength of the spirit used in these experiments is according to Tralles' alcoholometer which gives the percentage volume for the temperature of 60° F.

By fractional distillation of oil of nutmeg, Semmler§ isolated a body having the peculiar odour of mace, and represented by the

* Pharm. Journ. [3] iv., p. 311.

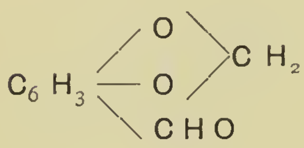
† Flückiger and Hanbury, Hist. des drogues, ii., p. 219.

‡ Pharm. Journ. [3] vi., p. 554.

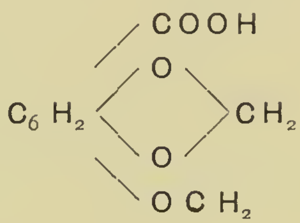
§ Ber. Deutsche. Chem. Ges. 1890, p. 1803.

formula $C_{10}H_{14}O_3$, which he called *Myristicin.* The correctness of the formula was verified by the preparation of a bromine derivative,—*dibromyristicin* $C_{12}H_{14}Br_2O_3$—which melts at 105° C.

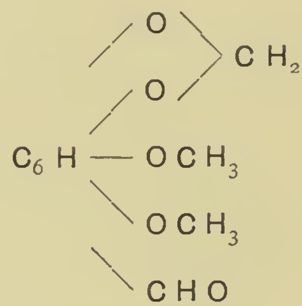
Another communication from Semmler to the Berlin Chemical Society* announces the discovery in mace oil of an odorous constituent forming white crystals melting at 30°·25 which is shown to be the butenyldioxymethylene—methoxyl derivative of benzene. By oxidation with potassium permanganate it yields *myristicinic aldehyde* $C_9H_8O_4$, the butenyl group (C_4H_7) being converted into the aldehyde group—C H O. *Myristicinic aldehyde* forms white crystals melting at 130°; it occupies a position intermediate between *piperonal* and *apiolaldehyde* :—



Piperonal.



Myristicinic aldehyde.



Apiol aldehyde.

Further oxidation of the aldehyde yields *myristicinic acid* $C_9H_8O_5$, a yellowish-white crystalline substance melting at 208°-210° C.; by treating this with a strong reducing agent, gallic acid is formed, from which Semmler infers that the three oxygen atoms attached to the benzene ring are in the ortho position relatively to each other, and that the carboxyl group is in the meta position to one of them.

During the operation of distilling nutmegs, or towards the end of a long distillation, it has been noticed that a crystalline matter collects with the oil on the surface of the water. In the crude state it appears as a greyish semi-solid mass, smelling strongly of nutmegs. By purification by washing with cold spirit of 0·830 and repeated crystallisation from boiling spirit, this body can be separated in the form of large brilliant colourless scales. Professor Flückiger who made the original investigation† states that the crystalline form of the scales could not be ascertained, as they never fully

* Ber. Deutsch. Chem. Ges. XXIV., 3818.

† Pharm. Journ. [3] v. p. 136

developed. In polarised light they prove to be doubly refractive. The alcoholic solution is devoid of rotatory power. It reddens litmus slowly, but very decidedly and permanently. In water, the crystals are insoluble. They melt at 54·5 C. and evolve offensive vapours, like a fatty substance ; if they are heated in a glass tube, no crystalline particles are sublimed. On platinum foil they burn, leaving no residue, giving off at first the same vapours as when heated in a glass tube. No difference could be observed between the purified crystals obtained from common nutmegs and those obtained from long nutmegs. The ultimate analysis of the same from both sources likewise corroborating their identity.

In caustic alkalies, the crystals of this so-called *Myristicin* (of course totally distinct from Semmler's Myristicin above referred to) dissolve readily : if a somewhat considerable quantity is dissolved in warm caustic lye, it will form, on cooling, a consistent jelly, which, in fact, is nothing else than a soap. "Myristicin" warmed for a day or two with absolute alcohol and an excess of anhydrous carbonate of sodium, yields, on cooling, a gelatinising *neutral* solution. If this solution is liquified, filtered and mixed with an acid, a crystalline layer will, on cooling, make its appearance on the surface of the liquid. This layer may be collected, washed with water, until the latter no longer reddens litmus, and then re-crystallized from hot alcohol, when crystals are obtained which prove to agree in every way with the original "Myristicin." If this process of purification is repeatedly carried on with the same quantity of the substance, the odour of the latter diminishes, and at last disappears.

After this complete purification from the essential oil with which the crystals are contaminated, they proved on analysis to be composed of :—

	I.		II.
Carbon	73·27	...	73·41
Hydrogen.........	12·25	...	12·25
Oxygen............	14·48	...	14·34
	100·00		100·00

As a result of these researches, the Professor remarks in his paper read at the British Pharmaceutical Conference :—"It became now evident that I had before me *Myristic acid* (the body was formerly considered to be a stereoptene and was named *Myristicin*),

which, in the form of *Trimyristicate of Glycerin*, is the chief constituent of the fatty part of nutmegs. The formula of the acid $C_{14}H_{28}O_2$ requires:—

14 C......	168	...	73·68
28 H......	28	...	12·28
2 O......	32	...	14·04
	228		100·00

"The melting point of myristic acid is stated by Heintz to be 53°·8; my crystals melted not before 54° or 54°·5. Whether this difference is due to the perfect, I may say, unrivalled, purity of my acid, or to a different way of observation, may remain undecided.

"It is not astonishing to meet with myristic acid in the product of a prolonged distillation of nutmegs, for fatty acids generally are capable of being volatilized, especially by means of superheated steam, when the vegetable fats are resolved into glycerin and fatty acids. It is possible that free myristic acid is present in the nutmeg itself, and this would still more easily be carried over by the watery vapour. I have warmed a little powdered nutmeg with alcohol and anhydrous carbonate of sodium and thus got a small amount of indubitable soap, from which I isolated myristic acid. This experiment shows that nutmegs contain a little free myristic acid."

Expressed oil of Nutmegs, "Nutmeg butter," "Concrete oil of nutmegs" or "Balsam of nutmegs." Crushed fresh nutmegs, or imperfect, broken nutmegs, crushed while fresh into a paste, are enclosed in bags and submitted to hydraulic pressure between heated iron plates. The yield is from 20 to 25 per cent. It is at first liquid, but congeals on cooling into an unctuous orange-brown body of marbled or mottled appearance. It is imported into London principally from Singapore, in oblong cakes of the shape of bricks, but somewhat smaller in size, enveloped in palm leaves or "flag-leaves." It was formerly brought into European commerce *via* Holland. At present, much of this "expressed oil" is manufactured in Europe, and put up in the same shaped blocks as that prepared in the East, but it is packed in paper. When discoloured and hardened by age, it is called "Banda Soap." Its odour is very agreeable and its taste greasy and aromatic. It melts at 45°C. and dissolves completely in two volumes of warm ether and in four volumes of warm alcohol of 0·800. It contains

about six per cent. of volatile oil of nutmeg, to which its odour and taste are due. It consists principally of a vegetable fat called *Myristin*, $C_{45} H_{86} O_6$ (*Propenyl trimyristicate*) which can be extracted by benzene or ether from the portion of butter which is insoluble in cold alcohol; it forms crystals which melt at 31°C. By saponification it furnishes glycerin and myristic acid $C_{14} H_{28} O_2$, which is fusible at 53°·8C. According to Mulder, myristin exists in small quantity in the fixed oils of linseed and poppy-seed. It is also found in several vegetable oils and fats and in spermaceti. The "butter" contains several other fatty bodies (one of which is found in the portion which is most soluble in alcohol and benzene) which have not been investigated, and a red colouring matter. A small quantity of uncombined myristic acid is also present.

A false butter of nutmegs has been noticed by Playfair, composed of animal fat boiled with powdered nutmegs and flavoured with sassafras.

Composition of Mace.—The nature of the principal constituents of Mace can be deduced from the following experiments*; "Seventeen grammes of finely pulverised mace were entirely exhausted by boiling ether, and the solvent left to spontaneous evaporation. The residue, amounting to 5·57 grammes, after desiccation at 100°C. was reduced in weight to 4·17 grammes. The loss, 1·40 gramme being the essential oil, which was consequently 8·2 per cent. The residue, amounting to 24·5 per cent. was a thick aromatic balsam in which we could find no trace of the presence of fat; it consisted of resin and semi-resinified essential oil. Alcohol extracted from it 1·4 per cent. of an uncrystallizable sugar which reduced cupric oxide. The drug, after treatment in this way with alcohol and ether, yielded scarcely anything to cold water, but boiling water extracted 1·8 per cent of mucilage, which assumed a blue coloration under the influence of iodine or a reddish-violet after having been previously dried. This substance is not soluble in an ammoniacal solution of cupric oxide; it seems rather to be an intermediary body between gum and starch. The composition of mace appears therefore very different from that of nutmegs."

As regards this "intermediary body between gum and starch," Tschirch states that "the aril of *Myristica fragrans* furnishes a

* F. & H. Hist. des drogues, ii. p. 223.

good illustration of the presence of *amylodextrin* as a normal cell-content in the place of starch. He says it is distinguished from true starch by being stained reddish-brown instead of blue by an aqueous solution of iodine. The grains of amylodextrin do not appear to contain even a nucleus of starch. As seen under the microscope they have usually somewhat the form of a rod and are often curved or coiled; less often they are roundish or disc-shaped; they do not usually exhibit any evident stratification.*

According to Dr. Hefelmann, the adulteration of powdered mace in Germany generally consists in the addition of Bombay mace or of other vegetable material (leguminous fruits) coloured with turmeric. The presence of the latter is shown by the presence of starch cells, which are not present in mace. Bombay mace may be detected by boiling the suspected sample with alcohol and filtering through a white filter; in the case of pure mace, the filter is stained a faint yellow, but in the presence of Bombay mace, the filter, especially the edge, is coloured red. Another more delicate test is to add Goulard's extract to the alcoholic filtrate; with pure mace only a white turbidity is occasioned, but when Bombay mace is present, a red turbidity is obtained. The reaction given by turmeric is similar, but it may be distinguished from that of Bombay mace in the following manner :—A strip of filter paper is saturated with the alcoholic solution, the excess of fluid removed, and the strip drawn through a cold saturated solution of boric acid; when Bombay mace is present, the paper remains unchanged, but in the presence of turmeric it turns orange-brown. If a drop of potassium hydrate solution is now placed on the strip of paper, it causes a blue ring if turmeric is present, and a red ring if the adultrant is Bombay mace.†

The yield of volatile oil of mace has been very variously estimated by different observers: Herrings & Co., having found it to be 6 per cent.;‡ Flückiger and Hanbury, 8·2 per cent.; § Schimmel & Co.,|| 11 to 16 per cent. This oil is colourless and very fragrant; its sp. gr. is 0·858 at 10°, 0·855 at 15° and 0·852 at 20° C. (Schimmel); Guibourt states it to be 0·928; his sample was

* Pharmacographia Indica, iii. p. 195.

† Pharm. Zeit., 1891, p. 122. See also Tschirch, an authority above quoted, Pharm. Zeit., 1881, 74.

‡ F. and H. Hist. des Drogues ii., p. 223.

§ Ibid.

|| Bericht, Oct., 1887.

probably contaminated with the red, fixed oil of mace, that body being, as he states, soluble in the volatile oil. Flückiger found that oil of mace deviates the polarised ray 18°·8′ to the right in a 200 millimetre tube. The principal constituent of the oil was termed by Schacht *Macene*, a hydrocarbon $C_{10}H_{16}$ boiling at 160° C., distinguished from oil of turpentine in that it does not form a crystalline hydrate on being mixed with alcohol and nitric acid. Macene, by treatment with hydrochloric acid gas, yields crystals of $C_{10}H_{16}H\ Cl$, which oil of nutmegs, similarly treated, does not (according to Cloez).* Crude oil of mace contains, like oil of nutmeg, an oxygenated body, the properties of which have not been investigated.

Several species of *Myristica* furnish products more or less analogous, and, as before observed, several species are employed to adulterate the true spice. Aromatic products are derived from the *Myristica spuria* of the Philippine Islands, the *Myristica Madagascariensis* of Madagasca, the *Myristica Bicuiba* of Brazil, the *Myristica Otoba* of New Granada, and the *Myristica sebifera* (*Virola sebifera*, Aublet), the seeds of which furnish an abundance of aromatic yellow tallow, which is of crystalline appearance and suitable to the manufacture of candles.

The leaves of *Myristica fragrans* yield on distillation a colourless, exceedingly limpid oil with an agreeable and fine nutmeg-like odour and taste. This oil could be employed as a substitute for nutmeg oil.

An oil of nutmeg-like odour and flavour is also yielded by distillation of the leaves of *Eucalyptus alba.*

Apart from the ordinary adulteration with nuts of inferior species, nutmegs are frequently sent into the market after being subjected to distillation in the entire state and a quantity of the volatile oil extracted from them, being therefore comparatively valueless, and ingenious methods have been devised for dressing up inferior nutmegs to resemble good ones; the fraud has even been carried so far as to fabricate artificial nutmegs of bran, sawdust, clay and powder of nutmegs! The Chinese are great adepts in the art of adulteration, have in fact elevated it to the rank of a "fine art," but although most of their tricks are very clever, they have not been accused of such original audacity as the manufacture of nutmegs, papier-mâché hams, and such-like "properties" which can

* Journ. de Pharm. [3] xlv., p. 150.

only be played off occasionally. The adulteration of musk, oil of cassia, &c., is a recognised Chinese monopoly, now so well-known that those products, often adulterated to the extent of 50, 60 or 80%, are taken as merchantable commodities on the London market, leaving risk of loss principally to consumers, who either do not understand the methods of assay or trouble to apply them so long as they obtain "cheap" goods or such as will bear a little further adulteration if they have to be sold again in the crude state. English dealers are not more immoral than the Heathens.

The odour of nutmeg is observable in the leaves of *Temus moschata* when bruised :—*Temus moschata*,* a fine evergreen shrub belonging to the Natural Order *Magnoliaceæ*, ten feet in height, native of Chili, in which country it is called *Temo*. In English it is termed "Musk-scented Temus." The leaves are crowded on the branches, alternate, oval, smooth, green and shining, 2 inches long, stalked. The flowers are sweet-scented, calyx 3-cleft; petals 18, linear, flesh-coloured, narrow, 2 or 3 inches long. Stamens 26, shorter than the petals; anthers globose; ovaries 2, each terminated by a style; carpels 2; seeds arillate.

"**Plume Nutmegs**" See *Athcrosperma moschata*.

"**Jamaica Nutmegs**" or "American Nutmegs," sometimes called "Calabash Nutmegs" from the resemblance of the entire fruit to a small calabash, are the seeds of *Monodora Myristica* Gærtner.† Formerly only a single species belonging to this genus of *Anonaceæ* was known, but four others have been found in Western and Eastern tropical Africa. The original species, *M. Myristica* was described from specimens obtained from Jamaica, where it was supposed to have been introduced from South America, but there is more reason to believe it was taken there by the negroes from Western Africa. Also the genus was formerly regarded as anomalous among its congeners, on account of its ovary being supposed to consist of a single carpel, with the numerous ovules distributed over the whole of its inner surface (and it is mis-named accordingly, from $\mu o \nu o \varsigma$ one, and $\delta o \rho \alpha$ a skin); but it is now known that it does not essentially differ from the rest of the order, the ovary being in reality compound, consisting

*Molina, Saggio sulla storia naturale del Chili, p. 153; Jussieu, Genera plantarum, 435; D.C. prodr 1, p. 78.

† Fruct. ii. p. 194 t. 125 f. 1; Lunan, Hortus Jamaicensis p. 10; Dunal, Monographie des Anonacées p. 80.

of numerous parcels united together, the placentas becoming confluent, and giving the appearance of the ovules being irregularly dispersed over the whole surface.

M. Myristica is described as a small tree in Jamaica where it is cultivated, being only about 20 feet in height, but it grows to 50 or 60 feet in Lower Guinea.* The other species are small trees or shrubs in all of them the flowers are large, like those of *Unona undulata,* solitary and sweet-scented. They are characterised by their three outer petals being large and spreading, with crisped or waved edges, and the three inner ones heart-shaped and erect, meeting together at their apices. The outer petals of *M. Myristica* are of a bright yellow colour variegated with purple spots, and the inner ones whitish on the outside and downy, but shining and pale yellow, with crimson spots inside. The fruit of all the four species is perfectly smooth, yellow when ripe, globular, varying in size from that of an orange to a large melon, containing a number of seeds packed closely together with great regularity in the midst of a quantity of pulp. The seeds of M. Myristica contain a quantity of aromatic oil which imparts to them the odour and flavour of nutmegs, and as they likewise possess the same kind of interior structure they have acquired the vernacular names above mentioned.†

Sassafras.

Sassafras officinale, Nees. Syst. Laurins, p. 488. Woodv. Med. Bot. t. 31 ; Bigelow, Amer. Med. Bot. t. 35 ; Stevenson & Churchill, Med. Bot. iii., t. 126 ; Bentley & Trimen, Med. Pl. t. 220.

This was called *Laurus Sassafras* by Linnæus and is a small, hardy, deciduous tree of the Natural Order *Lauraceæ,* common in the woods of the United States, extending from Canada to Florida and Missouri. In the North it grows to the height of about 30 feet, but in the Central and Southern States it attains a height of

* R. Brown, Observations on the herbarium collected by Christian Smith in the vicinity of the Congo, p. 56.

† Interesting information on the subject of nutmeg is given in the following Works :—Crawfurd's Dict. Indian Islands, p. 304 ; Wallace's Malay Archipelago, i. p. 452 ; Hooker's Journ. Bot., iv. p. 83 ; Collingwood, in Journ. Lin. Soc. (Bot.), x. p. 45 ; Pharm. Journ., [1] ii. p. 516 ; Journ. de Pharm., 1864, p. 150 ; Royle's Mat. Med., p. 464. A good plate is in Roxb. Pl. Coromandel, t. 274, also Woodville Med. Bot. t. 238.

nearly 100 feet. It forms many slender, cylindrical branches. It has a rough, deeply furrowed or cracked bark, of a greyish-brown colour and very aromatic. The bark of the young shoots is yellowish or reddish-green. The leaves are alternate, on petioles about 1 inch long and remarkable for their variety of form on the same tree; those which open first from the bud being oval, entire and about four inches long; the next being of the same form with a lobe on each side, and the last to appear have regularly three lobes. The greenish-yellow diœcious unisexual flowers are in drooping racemose panicles, appearing with the leaves and immediately beneath them. There is no calyx: the corolla is divided into six narrow, greenish-white segments. The anthers are linear and 4-celled. The fruit is an oval drupe about the size of a pea, of a deep blue colour, supported erect on a red peduncle nearly 2 inches in length. The tree is quite hardy in the climate of England, but is rarely seen here.

The bark is much more fragrant than the wood, the root-bark being the most powerful, and that of the branches the most pleasant.

Imported sassafras varies in size, from "chips," which are light, porous and of greyish-yellow colour, to large branched pieces sometimes 8 inches in diamater. The dimensions of the actual root-pieces diminishes down to that of a quill. The external bark of the roots is spongy, rough and externally of dull greyish-brown, internally reddish-brown. The inner bark is light in colour and rich in essential oil. The wood of the root is tolerably soft and easily cut; it is of a dark reddish-brown colour and has the same agreeable odour and aromatic taste as the inner bark, but in a much more feeble degree. The inner bark, separated from the valueless external outer bark, constitutes a special article of commerce, in which a considerable business is done. It appears in irregular shaped, flat, bent, furrowed pieces, rarely larger than 4 inches in length by 3 inches in width, and from ½ inch to 2 inches in thickness. Its external surface is finely veined and interspersed with minute crystals of calcium oxalate. It is short-fractured, corky, of a brilliant cinnamon colour, strong agreeable odour and aromatic, slightly bitter taste. Examined under the microscope, it exhibits a great number of oil-cells and cells containing mucilage. The root also contains tannic acid, and a colouring matter analogous to cinchona-red.

In the Southern States it is commonly found in old fields and on thinly wooded slopes, and the land-owners are generally willing to allow it to be taken from the land without charge if the diggers fill up the holes and cut, pile, and leave on the land the trunks of the trees. Many farmers get large pieces of new ground cleared and grubbed without cost in this way. The roots, after being cleaned, are generally saleable at the rate of 20 cents. per 100 lbs.,* and everything that grows beneath the surface is good, but the buyer has to see that the stump is not cut higher than the surface of the ground and that all the earth and stones are knocked out from between the roots. If they are not thoroughly cleaned the custom is to deduct from 10 to 25 per cent. from the gross weight to cover such losses. The roots may be dug at any season, though those dug when the sap is down yield the most oil They are drawn out of the soil by levers and split up with axes and wedges to about the size of a man's leg, and are then fed into the chopping machine, which is a heavy iron disc or wheel, usually about three feet in diameter, firmly keyed to a strongly journaled shaft which revolves at about 600 turns per minute. The wheel carries from one to four steel cutter blades set in slots like a plane bit, the number of cutters being determined by the power available. A 25 h. p. engine driving a 4-cutter wheel will chop about 20,000 lbs. of root in three hours, and this quantity, in slices about a quarter of an inch thick, will fill a wooden tank ten feet in diameter and eleven feet high. Some of the large roots when brought in weigh over 1,000 lbs. each, but the smaller roots yield the largest percentage of oil. The cutter is fixed to a heavy wooden frame, and up against the inner face of the wheel a heavy oak piece is bolted about 14 inches square and long enough to reach across the frame,—about 4 feet. In this block a sort of chute is hollowed out, with the bottom inclined toward the cutter blades. This chute is lined with hardened $\frac{1}{4}$-inch saw-steel, and when the wheel is in motion the roots thrown into this chute are carried down the steel-shod incline and cut very rapidly. The tank (which constitutes the still) is made of 3 inch kiln-dried pine, which should be free from pitch. The staves are 4 to 5 inches wide, 12 feet long, tightly jointed, and strongly banded with six iron bands about 3 inches wide and $\frac{1}{8}$th inch thick. The upper and lower heads of the tank are made of the same materials as the

* Oil, Paint and Drug Reporter, 14 Sept., 1891.

staves. There is a false bottom perforated with auger holes put in about three inches from the solid bottom. The upper head is provided with a trap door for filling the tank, and a larger door is fitted in one end of the bottom of the tank for taking out the exhausted chips. This lower door is luted with clay and keyed in place. The chips are loaded in from above, and when the tank is full the upper door is luted in and securely keyed up. Between the false bottom and real bottom of the tank steam is admitted through a 1¼ inch pipe. The steam, at 40 lbs. pressure, is at first admitted cautiously, but after it has permeated the mass of chips and has made its way to the top, which usually takes about three hours, the pressure can be increased to 50 or 60 lbs. The steam passes through a copper head fitted into the upper part of the tank, and thence through a coil of pipe in a tank of cold water; a 2 inch stream of cold water being kept running through the condensor during the whole time. It usually takes about fifty hours continuous steaming to exhaust the oil (by this process) from 20,000 lbs. of chips; the average yield being about a gallon of oil from each 1,000 lbs. of chips. The stream of condensed products which runs from the worm is caught in a copper funnel having a very long spout which reaches nearly to the bottom of a copper vessel of about 20 gallons capacity. This vessel has a spout near the top through which the waste water overflows, while the oil, being heavier than water, remains at the bottom, and is drawn off by a tap in a thin, steady stream during the process of distillation.

The bark should be collected late in the autumn, or in the spring before the leaves appear. The pith is principally derived from the branches and twigs, and is said to be most valuable if obtained in the autumn after a frost.

The bulk of the commercial oil of sassafras is produced in the United States, and the principal market for the roots, bark, pith* and oil are New York and Baltimore. The above-mentioned yield

* The pith is not employed as an aromatic. It is found in slender cylindrical pieces, which are very light and spongy, with a slightly mucilaginous taste, and when fresh a feeble flavour of sassafras. It forms a limpid mucilage with water. This mucilage may be prepared by adding 60 grains of the pith to a pint of boiling water. It is much employed in the United States as a demulcent application in inflammatory affections of the eyes, and as a soothing drink in catarrhal and other diseases where demulcents are useful. It differs from mucilage of gum arabic in remaining liquid when alcohol is added to it.

of oil appears small, barely 1 per cent., compared with the yield obtained in Europe from imported chips, which is found to be about 2 and even 2½ per cent. The yield, of course, varies with the quality of the chips, *i.e.*, the part of the tree derived from, and the amount of bark on them; the bark yielding at least twice as much oil as the wood.

The oil when first distilled is colourless or pale yellow, but it becomes reddish by age. The sp. gr. of American oil has been recorded as 1·070 to 1·085; samples distilled from imported chips have been found to vary between 1·06 and 1·09, but as a general rule the figures 1·065 at 15° C. may be taken as standard requirement. The New York firm of Schimmel & Co. exhibited at the Chicago Exhibition two samples of sassafras oil distilled at their works, viz.:—

Sample 1.—Oil from root-bark.	Yield 7·4 per cent. Sp. gr. at 15° C. 1·075. Optical rotation + 3° 16′ (100 m.m. tube).
„ 2.—Oil from wood of root.	Yield 0·9 per cent. Sp. gr. at 15° C. 1·075.

Crude oil of sassafras is composed of about 90 per cent. of *Safrol*, $C_{10}H_{10}O_2$ held in solution by 10 per cent. of Safrene. $C_{10}H_{16}$. It also contains a very small amount of a phenol-like body,* which gives a bluish-green coloration with ferric chloride.

In order to separate the pure Safrol from the oil, the fraction of oil boiling between 228° and 235° C. is refrigerated to —25°, at which temperature the safrol is deposited in strongly-refractive, mono-symmetric crystals of more than a decimètre in length and of 3 to 4 centimètres diameter, melting at 8 to 12° C. (53°·6 F.).† The large crystals of safrol are very little softer than those of gypsum. Safrol has a pleasant aromatic odour, boils at 232°—233° C., is insoluble in alkalies, and is not attacked by sodium. Its sp. gr. in the crystalline state is 1·245, and in the liquid state 1·104 at 15° C.; it is then optically inactive. *Safrene*, on the contrary, is dextrogyre; its sp. gr. is 0·834 and its boiling point 156° C. The phenol-like body above-mentioned, as contained in the crude oil, is separable by the aid of caustic potash from the

* Monatschefte xi. 101.

† Flückiger in Pharm. Journ. [3] xvii., p. 989. Compare with Pogg. Ann. clviii., p. 244, and Jahresb. Chem., 1876, p. 910.

safrene or uncrystallisable portion of oil drained off from the crystals of safrol.

According to Dr. Poleck, safrol is an extremely stable compound, the oxygen not being contained in the molecule, as hydroxyl, but in much closer combination, all his attempts at its reduction being unsuccessful. In the behaviour of safrol towards reagents it presents no analogies with alcohols, ethers, phenols, quinones or other classes of organic compounds.* Dr. Poleck considers that it is probably a methylpropyl benzol, or cymol, in which four atoms of hydrogen of the benzol are substituted by two atoms of oxygen.

It has been shown by Eijkmann† that by means of permanganate of potassium, safrol yields *piperonylic acid* :—

$$C_6 H_3 \left(\begin{matrix} O \\ O \end{matrix} > CH_2 \right) COOH$$

therefore may be represented by the formula :—

$$\begin{array}{l} C_6 H_3 < \begin{matrix} O \\ O \end{matrix} > CH_2 \\ \quad \diagdown \\ \quad\quad C_3 H_5 \end{array}$$

Piperononylic acid is obtained by oxidising piperonal (now known in perfumery under the name of *heliotropin*, series i., p. 188) :—

$$C_6 H_3 \left(\begin{matrix} O \\ O \end{matrix} > CH_2 \right) CHO$$

and Poleck ‡ thinks that he observed piperonal among the products of the treatment of safrol with permanganate of potassium, for the action of this salt on safrol is by no means simple, 4 per cent. of piperonylic acid only having been obtained by him. The discovery of safrol in the oil of the Camphor tree, *Cinnamomum camphora*, was made by Messrs. Schimmel and Co., of Leipzig, in 1885, who now separate it out in a state of absolute purity from that oil and to an extent which probably exceeds the whole distillation of crude sassafras oil in the United States.

Safrol is identical with the body named *Shikomol* by Eijkmann,§ which is the chief constituent of the volatile oil of the fruit of *Illicium*

* Chem. Zeit., 1884, 1453.

† Recueil des travaux chimiques des Pays Bas, iv., 1885, p. 32, and "Referate" of the Ber. Deutsch. chem. ges., 1885, p. 281.

‡ Ber. Deutsche. chem. ges., 1886, p. 1096.

§ Receuil des Travaux chimiques des Pays Bas, iv., pp. 32 and 985.

religiosum, the false "Star Anise" of Japan, a tree belonging to the Order of *Magnoliaceæ* and locally known as "*Shikimino-Ki*" (the chief constituent of the oil of true Star Anise, *Illicium verum*, is *anethol* $C_{10}H_{12}O$). The hydrocarbon $C_{10}H_{16}$ named by Eijkmann *Shikimene* is probably analogous with safrene. (Its boiling point, according to Eijkmann, is 170° C.; that of safrene is 156°).

The odour of sassafras observable in the essential oils of several other plants is doubtless referable to safrol, although the proofs may not be on record.

Illicium parviflorum, Michaux Flora boreali Americani, i., p. 326:* a shrub of about three feet in height, belonging to the Natural Order *Magnoliaceæ*, native of Western Florida, near Lake George. The bark has exactly the odour and flavour of sassafras root, and the leaves are odorous.

The odour of sassafras has been observed in the bark of *Mesipilodaphne sassafras*, Meissne, a native of Brazil belonging to the Natural Order *Lauraceæ*. This genus also furnishes another aromatic, *M. pretiosa* Nees "Laurin." 237 (Syn. *Laurus Quixos* Lam. Enc. iii., p. 455). This tree is found in the woods near Para. It is called by the Portugese Páo or Casca pretoisa; its inner bark is of very sweet odour, resembling cinnamon mixed with orange flowers or bergamot. Its medicinal action is said to resemble that of Sassafras-bark.

Messrs. Schimmel & Co. state,* having received samples of this bark from Brazil, in curved pieces about a yard long, 2½ inches to 3½ inches wide and up to half an inch thick. By distillation, the bark yields 1·16 per cent. of an essential oil of strong cinnamic odour and of a sp. gr. of 1·118 at 15°C. This oil does not seem to contain cinnamic aldehyde, no crystals separating from it when shaken with solution of sodium bisulphite, although its presence seemed indicated by its odour. The taste of the oil may be described as pungent aromatic, and the sweetness, that was expected from its odour, was wanting.

"**Sassafras Nuts**," called "Puchury" or "Puchury Beans" by the Brazilians are the seeds, or rather cotyledons produced by the *Nectandra Puchury major* also by the *N. Puchury minor* of Nees

* Ventenat, "Jardin de Cels." t. 22; Loiseleur des Longchamps, "Herbier de l'amateur," t. 330.

† Bericht, April, 1893.

(Laurin. 328); trees growing in the woods of Tabatinga in the Province of Rio Negro, Brazil. Its leaves are oblong or elliptical, tapering to a narrow point, leathery or papery, smooth, reticulated, of the same colour on both sides. Peduncles axillary, short. The cup of the fruit is very large and spongy. The fruit, in the early months of the year, drop from their cups to the ground and are collected by the natives, cleaned of their flesh and pericarp and dried at a gentle heat. Their odour is between that of sassafras and nutmeg; that of the *Minor* has been compared to Balsam Peru. The odour of the bark has been compared to a mixture of cloves and fennel, also as being like sassafras when fresh.

"**Australian Sassafras**" is the name applied in Australia to the bark of *Atherosperma moschata*, Labillardière, a tree indigenous in Australia and Tasmania, found also in Chili. It is the only species of the genus here known. It is an aromatic tree with four-cornered branches, opposite leaves and pedicellate axillary solitary flowers, with two deciduous bracteoles. The flowers are monœcious. The male flower is campanulate, with a very short tube and eight lobes; and the ten to twelve fertile stamens are mixed with scale-shaped barren ones. The calyx of the female flower is the same as in the male; the ovaries numerous, sessile and distinct, with one cell and one ovule. The nuts are aromatic and are called "Plume Nutmegs."

"**New South Wales Sassafras**" is the bark of *Doryphora Sassafras,* which belongs to the Order *Atherospermaceæ* and is somewhat nearly related to the Sassafras of Tasmania above-mentioned. It differs however in having the anthers prolonged into a tail-like process. *D. sassafras* is the only species of its genus, it grows to a fine symmetrical pyramidal tree of 60 or 100 feet in height, with a diameter of 2 or 3 feet in the trunk, and is furnished with opposite, smooth, lanceolate or elliptical toothed leaves. The flowers are small, perfect and three together, supported on axillary peduncles shorter than the leaves, and enveloped by two silky bractes, each with a calyx-border of six divisions and twelve stamens, six fertile and six sterile; the fertile ones having the anthers prolonged into a tail. The ovaries are numerous and become one-seeded nuts, the styles remaining attached to the ripe fruits in the form of feathery awns. The leaves, bark and wood emit an agreeable aromatic odour.

"**Brazilian or Orinoco Sassafras**" is the aromatic bark of *Nectandra cymbarum* Nees. Laurin. 305. Syn. *Octea amara* Martius, a native of the woods of the Orinoco near San Fernando de Atabapo, where it is called "Sassafras"; it is also found in the ancient forests of the Rio Negro in Brazil. This tree is 100 feet in height. Its branches and all its parts are smooth. Leaves oblong-lanceolate, papery, shining above; they and the peduncles of the fruit, which are short at the base of the branches and new shoots, are quite smooth. The cup of the fruit is large, with a double edge. By making incisions in the trunk, an oil called *Aceite de Sassafras* is obtained* which probably contains safrol. A somewhat similar product, but in which it is not recorded that safrol exists, is obtained by piercing the trunk of *Oreodaphne opifera* Nees, Laurin. 390. Syn. *Octea opifera,* Martius, a native of the woods of Para and the Rio Negro. This species of the genus is distinguished by its oblong, cuspidate leaves tapering into the petiole, silky on the under side; the panicles are compact, divaricating, silky. Its oval shaped fruit is succulent and imbricated in a deep, thick cup formed out of the altered tube of the calyx. This fruit yields by distillation a limpid, yellow volatile oil, differing in odour to that obtained from the trunk and reminding of a mixture of orange peel and rosemary.

The so-called "**Cayenne Sassafras**" is derived from *Licaria Guianensis* Aubl. Guian. i., p. 313 t. 121 (Syn. *Dicypellium caryophyllatum* Nees. Laur. 344). This tree is found in Brazil and Guiana. Its wood is called "Bois de Rose" by the French settlers in Cayenne. Its native name is *Licari Kanali.* Its leaves are alternate, oblong, tapered to a very fine point, which is nevertheless bluntish, acute at the base, papery, smooth, netted on the under side. The fruit is drupaceous, ovate, depressed at the apex. The bark is odourous of cloves, with a hot, clove-like peppery taste and powerful tonic properties.

"**Oriental Sassafras**" is the produce of *Cinnamomum Parthenoxylon,* Meissner, and *C. glanduliferum* Meissner; the former tree belonging to the forests of Penang, Sumatra and Java (*Kayu-gadis* of the Malays), perhaps also in Tenasserim; the second in Nepal, Sikkim, Bhootan and Khasia, it is the "sassafras

* Hooker's Journ. of Botany, vii., p. 278.

of Nepal." Both of these are known for their odour resembling that of true sassafras.*

What is known in America as the "**Swamp Sassafras**" tree is the *Magnolia glauca*, a low-growing deciduous tree which has acquired this common name from the nature of the localities in which it grows and from the resemblance in its properties to *Laurus sassafras*. It is also known by the name "Beaver tree," because those animals eat the root and make use of the wood in constructing their dwellings.

An essential oil similar in odour to oil of Sassafras is developed in the leaves of *Amyris punctata*.† The whole of the trees of the genus *Amyris* are aromatic. *A. punctata* is an arboreous shrub native of Chittagong; about twelve feet in height, with a smooth, dark, rust-coloured bark and rather thin, spreading branches, the lowermost spreading near the surface of the earth. The leaves, which are from 12 to 18 inches long, alternate and pinnate, are entirely deciduous during the cold season, appearing again after the flowers in March. The leaves are marked with glandular dots and the odour of sassafras is very apparent when they are bruised. The numerous small white flowers are formed in terminal panicles.‡

It appears to be the opinion of Professor Flückiger that safrol is contained in the bark of *Beilschmiedia obtusifolia* Benth. and Hook.,§ an Australian tree which has been described by Bentham (assisted by Ferdinand Müller) in the "Flora Australiensis, v., p. 299, under the name of *Nesodaphne obtusifolia*. It is a large and handsome tree growing in Queensland, Rockingham Bay, Fitzroy River, Rockhampton, Archer's Creek (according to Leichardt), also in New South Wales, Clarence River. Hooker and Bentham ‖ ultimately unite the genus *Nesodaphne* to *Beilschmiedia* (a genus of the Order *Lauraceæ-Perseeæ* devoted by Nees to the pharmacist Karl Trangott Beilschmied (1793—1848) of Ohlan, Silesia).¶ The tree under notice is therefore to be called *Beilschmiedia obtusifolia*, Benth. and Hook.

* Waring, Pharmacopœia of India, p. 196.
† Colebrook in Trans. Lin. Soc. xv., t. 3 f. 5.
‡ Roxb. Flor. Ind. ii., p. 251.
§ Pharm. Journ. [3] xvii., p. 989.
‖ "Genera plantarum" iii. 1880, p. 152.
¶ Archiv. der Pharmacie, cviii. (1849), p. 126.

Dr. Joseph Bancroft, in his "Contributions to the Pharmacy from Queensland"* p. 11, states that the tree grows in the rich scrubs to the north of Brisbane. Its grey, rough bark, reddish-brown internally, has a strong aromatic adour and pleasant astringent taste, and is frequently used by bushmen to improve the flavour of their tea. The bark, according to Staiger, affords about 2 per cent. of volatile oil heavier than water and 9 per cent. of tannin. Professor Flückiger remarks that a fine sample of the bark, supplied to him by Mr. E. Merck of Darmstadt, agrees to some extent in its microscopic structure both with the bark of Cassia lignea and Sassafras. It is as much as half an inch in thickness and shows the same exfoliation due to secondary cork bands (rhytidoma) as the bark of Sassafras. On the other hand, it is much more fibrous than either of the above-named barks; its tissue being very rich in long, thin fibres, and in its outer layer there are scattered, not in large number, sclerenchymatous cells, having comparatively thin walls. The oil ducts of Beilschmiedia bark are neither very numerous, nor considerably large.

Massoi Bark.

This aromatic product has long been known as an article of commerce in the Malay Archipelago.† It is derived from a tree of the Laurel family (*Laurineæ*) which is indigenous and apparently confined to the forests of Southern New Guinea. The botanical determination of the species has long been desired, and, during the voyage of H.M.S. 'Challenger,' Mr. H. N. Moseley, one of the naturalists attached to the expedition, succeeded in obtaining specimens of the bark and the fruit, both of which were deposited in the Kew Museum.

Subsequently, during his travels in New Guinea, D'Albertis made a small collection of plants which were examined by the distinguished traveller and botanist, Beccari. The difficulty of identifying the so-called "true Massoi bark" was undertaken by the curator of the museum of the Pharmaceutical Society of London.‡ The attention of that able botanist was then called by the Director of the Royal Gardens, Kew, to the "Kew Gardens

*Colonial and Indian Exhibition, 1886.
†Kew Gardens Report for 1880.
‡Pharm. Journ. [3] xix., p. 465.

Report," above quoted from. The notification was acknowledged and abstracted into the Pharm. Journ. xix., p. 761; the quotation being continued as follows:—"Subsequently, during his travels in New Guinea, D'Albertis made a small collection of plants which were examined by the distinguished traveller, Beccari. I extract the following note from the appendix to the English Edition of D'Albertis's 'New Guinea' (vol. ii. p. 398, *Massoia aromatica*, Beccari, *Sassafras Gossianum**. In D'Albertis's collection there is but one small specimen of the bark of this Laurinea, which is highly aromatic, and in great request by the Malays as an article of commerce. I have been obliged to find a new generic term for this plant, which it is a positive error to call a *Cinnamomum* or a *Sassafras*, as has hitherto been the case . . . . The name *Massoia* is derived from 'massoi,' the Malay name of the plant."

Previous to this explanatory note from Kew, it was believed there were three distinct "Massoi" barks, produced respectively from *Cinnamomum xanthoneorum* Blume, native of New Guinea; *Cinnamomum Kiamis* Nees, of Java, Sumatra and Borneo, and *Sassafras Goessianum*, Teysmann & Binnendyk, native of New Guinea. The first and third named plants are probably identical, and the differences observable in Museum specimens, or dried specimens in Herbaria, may be attributable to the chance of those specimens having been taken from the tree in various stages of it growth, various times in the year and different parts of the tree; young leaves of a growing shoot being larger, more succulent and of different development than leaves taken near the part of inflorescence or at the period of inflorescence. Dried specimens of leaves of plants are of very little reliable value unless accompanied with full detailed description of the *part* of the plant taken from and *time* of the year when gathered. The appearances of *barks* must also vary with age of the tree; the *odours* of the barks also vary with age; the alterations taking place in the constitution and odour of essential oil in a plant is instanced by the seed of the Coriander. Bearing these facts in mind, and having regard to the difficult tangle in which the Massoi Barks were involved as recently as 1889 (and are not unravelled yet), it appears quite rational that the essential oil described by Messrs. Schimmel & Co. in their Report of Oct., 1888, was distilled from the *Massoia aromatica* of Albertis and Beccari, as stated by them, and not from a bark

*Of Teysmann & Binnendyk, Cat. Plant. Hort. Bot. Bogoriensis, 1886, p. 94.

mentioned by Mr. Holmes as being similar to *Cortex Culilabani Papuanus* in the Hanbury collection, the botanical origin of which is acknowledged to be "unknown." Slightly distinctive botanical peculiarities may be overlooked or misjudged by reason of defective or imperfectly described specimens—but an odour is never to be forgotten—especially by an experienced business nose.

Sassafras Goesianum, T. & B., *Cinnamomum xanthoneuron* Blume and *Massoia aromatica* Albertis and Beccari may be identical, but the Massoi bark of Java, Borneo and Sumatra (? *Cinnamomum Kiamis,* Nees) is of very little value commercially, having but very little aroma. It is referred to by Gmelin* as furnishing a light and a heavy essential oil and a camphor. The bark obtained by Messrs. Schimmel from the New Guinea Company has been found to contain about 7 per cent. of an oil having a specific gravity of 1·04, boiling betweeen 200° and 300°C, and containing about 75 per cent. of *eugenol.* The portion of the oil soluble in soda liquor boiled between 210° and 245°C., and among other compounds, contained *safrol.* The oil also contains pinene, limonene and dipentene. This bark has been minutely investigated by Dr. Neumann Wender of Lemberg† and compared with other kinds ; he there explains how the bark does not agree with either of the two in the pharmacological collection of the Allgem. österr Apotheker-Verein in Vienna. He observes further, that the Massoi tree, according to the anatomical structure of the bark, is undoubtedly that of a *Lauracea,* and that in other respects it agrees with the bark of *Sassafras Goesianum,* or of *Massoia aromatiea* above-mentioned.

Solidago Odora.

An essential oil is distilled from the fragrant leaves of this perennial herbaceous plant, which belongs to the tribe *Corymbiferæ,* and is indigenous to North America, where it is called "Sweet Scented Golden Rod." (In French, *Verge d'or ;* and in German, *Goldruthe*).‡ The powerful odour of this essential oil has been compared to a mixture of anise and sassafras. The sp. gr. of the oil is 0·963.

*"Handbuch" iv. p. 356.

†Zeitschrift des Allg. österr Apoth-Vereins, 1891, No. 1.

‡Plukenet, Phytographia stirpium illustriorum t. 116, f. 6.

Laurus Benzoin, or Wild Allspice.

It is stated that during the American war, when allspice was difficult to obtain in the United States, a substitute was found in the berries of *Laurus Benzoin*, Linn., sp. pl. 530 (Syn. *Benzoin odoriferum*, Nees, Laurin, 497; Barton, Mat. Med. ii. t. 33; *Laurus pseudo Benzoin*, Mich. fl. bor. am. i. 243), commonly known as "Spice-Wood," "Wild Allspice," "Fever-Wood," "Benjamin-bush" and "Spice-bush" (not the Californian "Spice-bush," which is *Oreodaphne Californica*, described hereafter), a deciduous North American shrub of the genus *Lauraceæ*, inhabiting damp, shady woods in localities extending from Canada to Florida. This bush grows to a height of eight or ten feet, has oblong-ovate or elliptic wedge-shaped leaves and small yellow flowers in clustered naked umbels appearing before the leaves. The aromatic fruit is the size of an olive, bright red, and in clusters. The bark is highly aromatic, stimulant and tonic.

For the purpose of ascertaining the amount of fixed and volatile oils in the berry of this plant, an examination was made by Dr. Miller, of Philadelphia,* with the following results: ". . . Fifty pounds of the spice berries, in very fair condition, were reduced to a coarse powder in a mill, and then subjected to a hydraulic pressure of 2,000 lbs. on the square inch of surface. Only very little oil having been obtained in this manner, the ground berries were removed from the press, moistened with water, and at the same time gently warmed by means of a steam-bath. After being re-introduced into the cylinder of the hydraulic press under these conditions, the berries yielded a comparatively large proportion of viscid oil. This was separated from the water accompanying it and then filtered. It was found to weigh 16 lbs. 8½ ozs., being about 33 per cent. of the crude drug. It has a consistence similar to that of castor oil, a greenish-brown colour and a pungent aromatic taste. Its sp. gr. was found to be 0·929. Mixed with double its volume of 94 per cent. alcohol, only 12 per cent. of it was dissolved, but it was miscible with ether in all proportions. The expressed residue was next introduced, along with sufficient water, into a still heated by a steam-jacket, but though the operation was continued for a number of hours, only 123 grains of volatile oil were obtained from the entire mass, showing that the

* Proc. Am. Pharm. Assoc., 1879, p. 772.

great bulk of this constituent had been expressed along with the fixed oil.

"The dregs remaining in the still were then carefully dried, and two lbs. of them were percolated with 'gasolin' (it is presumed that benzene is here meant) until exhausted. After this menstruum had been entirely removed by spontaneous evaporation, a residuum of thick fixed oil and resin were left, weighing $7\frac{7}{8}$ ozs. This amount corresponds very nearly to 25 per cent. of the weight of the expressed berries, or to about 17 per cent. of the original weight of the drug, making, together with the 33 per cent. previously obtained by expression, just 50 per cent. of oily and resinous constituents. From this amount, however, the percentage of volatile oil subsequently obtained by distillation from the expressed oil is to be subtracted. The sp. gr. of this residuum was identical with that of the expressed oil, viz., 0·929. The two oils were also closely analogous to each other in their colour and consistence, but the taste of the expressed oil is far more aromatic than that of the residuary product. When the latter was shaken up with three times its volume of alcohol, about two-thirds of it was readily dissolved. It was freely soluble in ether. When subjected to distillation with water, the water came over almost tasteless.

"One hundred ounces of the expressed oil (corresponding to about 300 ounces of the crude drug) were then submitted to distillation, being heated by steam. A yield of $2\frac{7}{8}$ ounces of volatile oil was thus procured, being somewhat less than one per cent. of the original weight of the berries. The residue remaining in the still was increased in density to 0·931. The essential oil has a sp. gr. of 0·850; it is thin, bright green in colour, and has a warm, aromatic taste somewhat resembling that of allspice and prickly ash. The residue of the 'spice-berries' remaining after the expression and subsequent exhaustion by 'gasolin' was almost tasteless." The bark of this shrub was subjected to chemical examination by Morris Jones,* who found it to contain "a volatile oil belonging to the cinnamyl series, yielding, by the action of oxidizing agents, a product having the odour of oil of bitter almonds." With the view of ascertaining exactly the amount and qualities of the volatile oil yielded by this shrub investigations were made by Schimmel & Co. in their laboratory;

* Am. Journ. Pharm., 1873, p. 300.

the following are the results published in their Report of October, 1890:—

"All parts of the shrub possess pleasant aromatic odours, which, however, are strikingly different from one another. We obtained by distillation with water:—

a. From the bark, about 0·43 per cent. of an oil smelling like wintergreen. It possessed a sp. gr. of 0·923, and boiled between 170° and 300° C.

b. From the berries, the abundant quantity of 5 per cent. of an aromatic, spicy and camphoraceous smelling oil, the sp. gr. of which we determined as 0·855. The boiling point lies between 160° and 270°. This oil has been already prepared by Dr. A. W. Miller, who obtained a yield of about 4 per cent., and found the sp. gr. to be 0·850.

c. From the twigs, about 0·3 per cent. of an oil smelling like camphor and calamus. Sp. gr., 0·925.

d. From the leaves, about 0·3 per cent. of an oil with a very pleasant lavender-like smell. Sp. gr., 0·888."

Canella Alba.

The bark known in the Drug trade by this name, and sometimes called "Wild Cinnamon" and "White Wood," is the produce of *Canella alba* Murray, Linn. Syst. veg. iv., p. 443; Syn. *Winterania Canella*, Linn. *Canella Winterana* Gærtn., an aromatic tree of the Nat. Ord. *Canellaceæ*, found in the south of Florida, the Bahama islands, Cuba, the wooded hills of Jamaica, Sainte-Croix, Gaudaloupe, Martinique, Barbadoes and Trinity. It is figured by Swartz in Trans. Linn. Soc. i., p. 96, t. 8;* P. Browne, Civil and Natural Hist. of Jamaica p. 215, t. 37, f. 3; Plunkett, Phytographia, t. 160, f. 7; Sloane, Voyage to Madeira, Barbadoes, Jamaica, ii., p. 87, t. 191, f. 2; Bentley and Trimen, Med. Plant., t. 26.

This evergreen tree ranges from 15 feet in height, attaining in some localities 40 feet. It is branched only at the top; the bark is whitish or silver-grey, by which it is easily recognized in the woods. The leaves are numerous, alternate, without stipules, shortly stalked, 2 to 5 inches long, oblong-ovate, blunt at the apex, tapering at the base, quite entire, thick, smooth, shining above, pale below, the younger ones with immersed pellucid glands. The

* Copied into Woodville Med. Bot. t., 117.

violet-coloured flowers grow at the top of the branches in clusters upon divided peduncles; they are small and seldom open; the calyx of three sepals is permanent; the 5 petals are coriaceous and deciduous. The berry, about the size of a large pea, is fleshy, smooth, blue-black when ripe; the receptacle is the central angle of the cells. The seeds, generally 2, sometimes 4, immersed in mucilage, are usually globular and beaked, always very smooth, black and shining; the outer skin is crustaceous, thin and brittle, the inner of a bay-brown colour.

The whole tree is very aromatic, especially the flowers, which, although they seldom open, perfume the whole neighbourhood; when dried, and softened again in warm water, they have a fragrant odour, nearly approaching to that of musk. Also the leaves are very odorous. Pigeons feed greedily upon the berries, the peculiar aromatic flavour of which is so strong as to be communicated to the flesh of these birds. The bark of this tree is brought to Europe in the form of long quills, somewhat thicker than cinnamon. The name *Canella* is derived from this peculiarity of being rolled up like cinnamon, the word *canna* meaning "a reed." In the Bahama islands, where this bark is known as "White Wood Bark" or "Cinnamon Bark," it is collected by first gently beating the tree with a stick, so as to detach the greater part of the outer cuticle (the *epiphlœum*), the remaining portions of the bark are then peeled off and dried in the shade. It sometimes happens that a second beating of the tree is necessary to loosen the inner bark.

As imported, this bark appears in pieces of irregular shape and size, more or less crooked, their length varying from 2 inches to a foot or more, and the width from half an inch to one or two inches, channelled, the outer surface yellowish-white, chamois colour, or light brown. On the outer surface (the *mesophlœum*) there occasionally remains here and there a patch of the *epiphlœum*, silver-grey in colour and dotted with minute lichens, and the inner surface, which is of a light cinnamon colour, may be marked with longitudinal fissures, caused by the process of beating. The transverse fracture is short and exhibits the three cortical layers of which this bark is composed; of course, where the epiphlœum has been detached, the two under layers only are seen, the upper one containing numerous large, yellow-coloured oil-cells. The microscopic structure is described and illustrated in Flückiger and Hanbury's Hist. des Drogues, ii., 39. The odour of this bark is

very aromatic and approaching that of Ceylon cinnamon, its taste is hot and bitter, differing much with that of cinnamon and approaching that of a mixture of cloves and cinnamon. The essential odorous constituent was found by Meyer and Von Reiche (who studied this bark under the direction of Wöhler) to be a volatile oil, amounting to about 0·94 per cent. According to these observers, the oil is composed of four distinct oils; the first is identical with eugenol; the second is closely allied to the principal constituent of oil of cajuput, and the other two oils requiring further investigation.* On distilling 20 lbs. of bark, Flückiger and Hanbury obtained 0·74 per cent. of oil, which, on being distilled with caustic potash in excess, was found to consist of two parts of an oxygenated body and one part of neutral hydrocarbon of an odour resembling that of a mixture of mint and cajuput. Messrs. Schimmel have obtained 1 per cent. of oil from this bark; its sp. gr. at 15°C. being 0·922, and it was found to contain eugenol and cineol. Canella also contains 8 per cent. of mannite, gum-resin, starch and a bitter principle. Canella has sometimes been known under the following names: "Costus corticosus," "Costus dulcis," "Cassia alba," "Cassia lignea Jamaicensis" and "Jamaica Winter's bark," but as it is quite free from tannic and gallic acids, it is readily distinguished from "Winter's bark" by giving no reaction with ferric salts. By the addition of potash to a cold aqueous infusion of true Winter's bark, a dark, somewhat violet, colour is also produced; whereas an infusion of Canella alba bark is but slightly altered under the same circumstances.

Canella axillaris, Martius (Syn. *Cinnamodendron axillare*), native of Brazil, yields a bark having the same properties as *Canella alba.* It is a tree of about 20 feet in height, with a white, smooth bark, cracking transversely. The leaves are elliptic, alternate, obtuse, quite entire, smooth and leathery, paler beneath, coriaceous. The flowers are axillary, nodding, decandrous, and have 3 bracts. The calyx consists of 3 rounded lobes. The flowers have 5 (rarely 4) sepals, with as many petals, which are sessile, ovate-orbicular. Crown of 5 obovate, ciliated segments, alternating with the petals. Tube short, girding the germen, bearing 10 sessile anthers. Anthers 2-celled. Ovary ovate.†

* Gmelin Chemistry, xiv., p. 210

† Nees and Von Martius in Nova Acta physico-medica, &c., xii., p. 18.

Winter's Bark, above referred to, is the dried bark of *Drimys Winteri* (Forster Characteres generum plantarum, p. 84, t. 42; Syn. *Winterana aromatica*, Murray, Linn. Syst., 507), an evergreen tree attaining a height of 40 feet, belonging to the Natural Order *Magnoliaceæ*, discovered by Captain Winter in the vicinity of the Straits of Magellan, and now found in various countries from Mexico to Cape Horn. The word *δριμυς, acrid*, is in allusion to the taste of the bark. The tree has knotty branches, the bark is thick, aromatic and pungent. The leaves are oblong, obtuse, their under surface glaucous; the peduncles are almost simple, aggregate, divided into elongated pedicels. The flowers, which are axillary, are composed of 6 oblong petals, milk white, about the size of a hawthorn blossom, and having a perfume like *jasmine*. Berries from 3 to 6, of a light green colour, with a few black spots, usually containing 4 black, aromatic seeds. As the bark is met with in commerce it appears in short quills, or channelled pieces of very thick bark, often twisted or bent backwards. Externally the colour is ashy grey to brownish; internally it is rusty brown. The inner side is characterised by sharp striæ or longitudinal ridges with some minute cracks, as if the inner bark had contracted to a great extent in drying. These ridges are seen at the fracture to be the broken ends of white liber tissue. This radiating white liber serves to perfectly distinguish this bark from that of *Canella alba*. In England Winter's bark appears to be almost entirely used for medicinal purposes. It contains tannic acid or some nearly allied bodies, and on this account it is used in Chili for tanning purposes. It also contains a resinous matter and 0·64 per cent. of an aromatic essential oil of sp. gr. 0·945 at 15° C.* Its decoction, on treatment with potash, becomes dark violet; this distinguishes it from *Canella alba*, which is but very slightly affected by the same treatment.

False Winter's Bark is the product of *Cinnamodendron corticosum*, Miers,† a tree attaining about 100 feet in height, indigenous in Jamacia, the only island in the West Indies where it has been observed. It has been known in that island for more than a century, although remaining unnamed until 1838, the date

* The essential oil of this bark has been examined by Avata and Canzoneri: Estudio de la Corteza de Winter verdadera. Buenos Ayres, 1888.

† Annals of Natural History, May, 1858; Contributions to Botany, i., 121, t. 24.

when Miers described it and classed it in the small genus *Cinnamodendron*, which is nearly allied to the genus Canella. It flourishes in the mountainous woods of Saint-Thomas-en-Vallée and Saint John.

It is remarkable that this tree should ever have been confounded with the *Canella alba*, from which it differs not only in the form of its leaves, but also in the disposition of its flowers, they being axillary, while those of *Canella alba* are terminal. It is described and figured in Bentley and Trimens Med. Plants, t. 27.

The bark of **Cinnamodendron corticosum** has been imported as Winter's bark and mixed with *Canella alba*, which it resembles both in colour and taste, but is of darker reddish-brown colour on both surfaces, and the inner surface is much more fibrous and rough; also, it contains tannin. A decoction of it is blackened by ferric chloride, a reaction which distinguishes it from *Canella*. It is distinguished from *Drimys* (the true Winter's bark) by its decoction being turned intensely purple by tincture of iodine, a reaction which a decoction of true Winter's bark is not subject to.

Canella de Cheiro. It may be opportune in this place to remark that this name is applied to a plant of very different character to any of the above-mentioned, viz., the *Oreodaphne opifera*, Nees (Syn. *Ocotea opifera*, Martius), belonging to the Natural Order *Lauraceæ*, a large tree found on the Orinoco, yielding an abundance of volatile oil from incisions made into its trunk. Another essential oil is also obtained from its fruits by distillation; this is very limpid, of a pale sherry colour, of aromatic, acrid taste, and an odour resembling a mixture of old oil of orange-peel and oil of rosemary. The leaves of this tree are oblong, cuspidate, tapering into the petiole, silky on the outer side. The panicles are compact, divaricating, silky.

Oreodaphne cupularis, Nees, Laurin. 438 (Syn. *Laurus cupularis*, Lam. Enc. iii., 447; Ill. gen., t. 321; "Bois de Canelle," Aubl. Guian., i., p. 363), is a very large tree found in Bourbon and Madagascar, producing a very strongly-scented wood. It is called the "Cinnamon of the Isle of France," also "Mauritius Cinnamon." Its leaves are ovate-elliptical, acute at each end (sometimes blunt at the apex), ending in a channelled stalk,

obsoletely netted, smooth; the axils of the costal veins without pores. Flowers in clustered, few-flowered, rough, hoary racemes below the axillary and terminal bud. Calyx of fruit nearly globose.

Oreodaphne Californica. (See "California Bay").

The odour of Cinnamon is noticeable in the aromatic, exstipulate leaves of a tree named **Cinnamosma,** native of Madagascar, and the only representative of this genus of *Magnoliaceæ* yet known. The small flowers which form in the axils of the leaves are invested by numerous over-lapping bracts: they have a calyx of three sepals, and what is very peculiar, a gamopetalous corolla, which increases in length with the age of the flower, and is divided above into 5 lobes. The ovary is 1-celled, with 3 parietal placentas.

The dried leaves of **Comptonia asplenifolia** (Syn. *Myrica asplenifolia*), or "Sweet Fern bush," yield 0·08 per cent. of a volatile oil with a strong spicy cinnamon-like odour; its sp. gr. is 0·926 at 15° C. When placed in a freezing mixture this oil becomes solid (Schimmel). The *Comptonia* is a deciduous bushy shrub, about three feet in height, belonging to the order Myricaceæ, bearing both male and female flowers in catkins and on the same plant. It is a native of North America, in most peaty soils. The leaves are long and narrow, alternately arranged and cut on each side into rounded and numerous lobes, so as to resemble the fronds of *Ceterach*; they are downy and sprinkled with golden resinous dots, which as well as the rest of the plant, have an aromatic scent. It is hardy, but requires a peat soil and shade.

An odour which may be allied with that of cinnamon and cassia is that of *Furfurol*, $C_5 H_4 O_2$, the aldehyde of Pyromucic acid. (See "Empyreumatic oils").

Pimento.

This aromatic, whose odour and flavour are considered to resemble a mixture of cinnamon, cloves and nutmeg, is for that reason commonly known as "Allspice." It consists of the dried, unripe berries of *Eugenia Pimenta* D. C. (Prodr. iii. 285), Syn. *Myrtus Pimenta* Lin. (sp. Pl. 276), *Pimenta vulgaris* Wight & Arnott and *Pimenta officinalis* Lindley.

It is figured in Lindley, Collectanta Bot. t. 19; Woodville Med. Bot. t. 77; Stevenson & Churchill, Med. Bot. t. 124; Bot. Mag. t. 1236; Nees t. 298; Tussac Flor. Antilles iv. t. 12; Wight

Pimenta officinalis
(reduced).

Illust. Ind. Bot. ii. t. 98 Fig. 7: and Bentley & Trimen Med. Plant., t. iii. (This last plate should be compared with that of *Pimenta*

acris t. 110 of the same work, the different character of the leaf and fruit formation of the two plants being at a glance apparent in these excellent plates).

This handsome evergreen tree is indigenous to the West Indies, and is found on calcareous soil near the coast, on the islands of Cuba, Hayti, Trinidad, Domingo, Antigua, all through the Leeward and Windward islands, and more or less in all the islands of the Carribean, but is most abundant in Jamaica; the groves of these spice trees found there are magnificent, and produce more than one half of the "all-spice" used in the United States. It is also found in Central America—Mexico and Costa Rica—and in Venezuela.

The usual height of the tree is from 20 to 30 feet, occasionally it is found over 40 feet. The trunk is slender, straight and upright, much branched at the top and covered with a smooth grey aromatic bark. The leaves are opposite, stalked, 4 to 6 inches long, oblong-lanceolate, somewhat tapering at the petiole, blunt and rather emarginate at the apex, entire, smooth on both surfaces, deep green, paler and minutely gland-dotted beneath, with the midrib prominent. They are particularly aromatic in the fresh state, abounding in essential oil.

In the month of July, the head of the tree is covered with an exuberance of very small fragrant flowers, the perfume of which is carried to a distance by the wind. These flowers are produced in bunches or trichotomous panicles at the extremities of the branches. The calyx is divided into four roundish segments. The petals are four, reflected, and of a greenish white colour. The filaments are numerous, longer than the corolla, spreading, of the same colour as the petals, supporting roundish, white anthers. The style is simple, erect, with an obtuse stigma. The fruit is a smooth, shining, succulent berry, crowned with the persistent calyx, of a black or dark purple colour when ripe and containing two kidney-shaped flattish seeds. The fruit, when ripe, is filled with a sweet pulp, and the aromatic property which so strongly characterises it in the unripe state, has in a great measure disappeared. The gathering of the berries therefore takes place as soon as they have reached their full size and whilst still green. They are gathered by hand and dried on mats placed on terraced wooden floors. During the first and second days they are often turned, to be fully exposed to the sun. When they begin to dry,

they are frequently winnowed, and laid in cloths to preserve them from rain and dews, still being exposed to the sun every day and removed under cover every evening till sufficiently dry, which usually happens in twelve days and is known by their having acquired a reddish-brown colour, also by the rattling of the seeds. Some planters kiln-dry the berries, especially when the crop is abundant ; security against rain being essential.

For gathering the berries from such parts of the tree as cannot be reached by climbing, recourse is had to ladders. The small twigs bearing the berries arranged in bunches, are broken off and brought down.

If the fruit is allowed to ripen on the tree, it falls to the ground, and in a ripe state is of no commercial value, for the reason above described. A problem which faces the pimento producer is therefore the rapid picking of the berries when they are just fully grown; this has recently been referred to by a Colonist in the following terms* :—"It is often difficult to secure enough help from among the indolent natives to pick the crop, and one large producer told me that he had lost fully 3,000 bags of his pimento, which had ripened and fallen to the ground, simply because he could get no one to pick it."

The pimento tree begins to fructify in three years after it is planted, and arrives at maturity at seven years, when it abundantly repays the patience of the planter. It is particularly fond of a white marly or chalky soil having a shallow surface of mould, and therefore thrives on rocky lands which are fit for little else.

Strictly speaking, the pimento tree is not really cultivated at all in Jamaica. The trees are found in greater or less numbers all over the island; but in some sections of the country they are the predominating trees, indigenous and growing wild. The nearest approach to cultivation is to clear away the underwood and keep the groves free from brushwood and creepers ; a difficult task where everything grows spontaneously in the wildest luxuriance. Sometimes the trees will be found singly, sometimes in groups of six, twelve or twenty. In other places a few hundred will be found; while in ten principal pimento districts in parishes of Manchester, above Kingston, and St. Ann's, there are great forests of pimento trees. These last-named mountainous districts are

* Oil, Paint and Drug Reporter, April, 1892.

some 6,000 feet above the sea level; the harvest there is gathered later than in the low-lying districts near the coast. After the drying process is completed the pimento is packed in bags, very much in the same way as coffee, and transported to the coast for shipment. The principal port of shipment is Kingston, but large quantities of the crop are shipped from various other ports along the coast. The total export of pimento from Jamaica in the year 1889 was, 46,179 cwt., valued at £47,842, of which the United Kingdom took 21,267 cwt.

In the dried state pimento is a small, dry, light, roundish fruit, which varies somewhat in diameter, but is on an average about the size of a small pea. It is crowned with the remains of the calyx in the form commonly of a slightly elevated scar-like ring; and rarely at the other extremity of the fruit there is a short stalk attached. Pimento consists of a brittle, somewhat woody shell or pericarp, of a dark brown colour externally, and is more or less rough on its surface from the presence of small receptacles of oil; and of two dark, brownish-black somewhat compressed, kidney-shaped seeds, each of which is contained in a separate cell. The aromatic properties are more evident in the shell than in the seed.

Pimento berries yield, on distillation, from 3 to 4½ per cent. of volatile oil, composed mainly of eugenol, and very closely agreeing, in all respects but its odour, with oil of cloves; the difference in odour is attributed to a slight difference in the nature of the sesquiterpene accompanying the eugenol. The sp. gr. of this oil is 1·04 to 1·05 at 15° C. The yield of oil from the *leaves* is nearly 1 per cent.

The investigations of Dragendorff* prove that the miscibility of pure oil of pimento in alcohol of various strengths is as follows:—

1 cubic centimetre is soluble in 87 per cent. alcohol in all proportions,
„ „ in 1·1 c.c. of 73 per cent. alcohol,
„ „ in 1·5 c.c. of 69 per cent. alcohol,
„ „ in 2·8 c.c. of 63 per cent. alcohol,

therefore approximating in solubility to oil of cloves, and the admixture of copaiba oil is easily detected. (The strength of the spirit used in the various experiments is according to Tralle's alcoholometer, which gives the percentage volume for the temperature of 60° F.).

* Pharm. Journ. [3], vi. p. 544.

Pimento berries are globular, from 4 to 6 millimetres in diameter. They are sometimes adulterated with a Mexican spice called "Pimenta de Tabasco," which are larger berries and less aromatic; these are produced by the *Myrtus Tabasco*, Mocino et Sessé.* This tree is a native of the hot regions in Mexico; its leaves are elliptic—lanceolate, acute at the base and obtuse at the apex, full of pellucid dots. It is considered to be a variety of *Eugenia Pimenta* D.C. (the true pimento).

Another tree, equally as variable as *Eugenia Pimenta*, and yielding analagous products, is *Myrcia Pimentoides* D.C., Syn. *Myrtus Pimenta latifolia*, Roxb.,† *Myrtus citrifolia*, Poir,‡ and *Eugenia citrifolia* of the same author. It is a native of the West India Islands, and now cultivated in the East Indies. It differs from *Eugenia Pimenta* in the branches being acutely tetragonal. The leaves, berries and flower-buds have a hot taste and fragrant smell like like those of *Myrcia acris*, from which the West Indian "Bay" leaves have long been considered to be produced.

West Indian Bay.

Although the United States Pharmacopœia names the oil of Bay "Oleum Myciæ," and states it to be derived from *Myrcia acris* D.C., there is some doubt about the accuracy of the statement, the species, varieties and forms of Myrcia and Eugenia being so numerous and so nearly allied that it is probable that the leaves commercially known as "Bay leaves" are gathered from various trees, and no attention is paid by the gatherers to the slight structural differences which distinguish botanically between the various trees. Recent opinion is in favour of these Bay-leaves being derived from *Eugenia acris*, Wight and Arnott (*Pimenta acris* Wight Illust. Indian Bot. ii. p. 16).

Myrcia acris, D.C. (Prodr. iii. 243) figured by Hooker,§ is considered to be identical with *Myrtus acris*, Swartz‖; *Myrtus Caryophyllata*, Jacq.; *Caryophyllus racemosus*, Miller dict.; *Myrtus*

* "Flora Mexicana" ex Chamisso et Von Schlechtendal in "Linnea," v. p. 559.

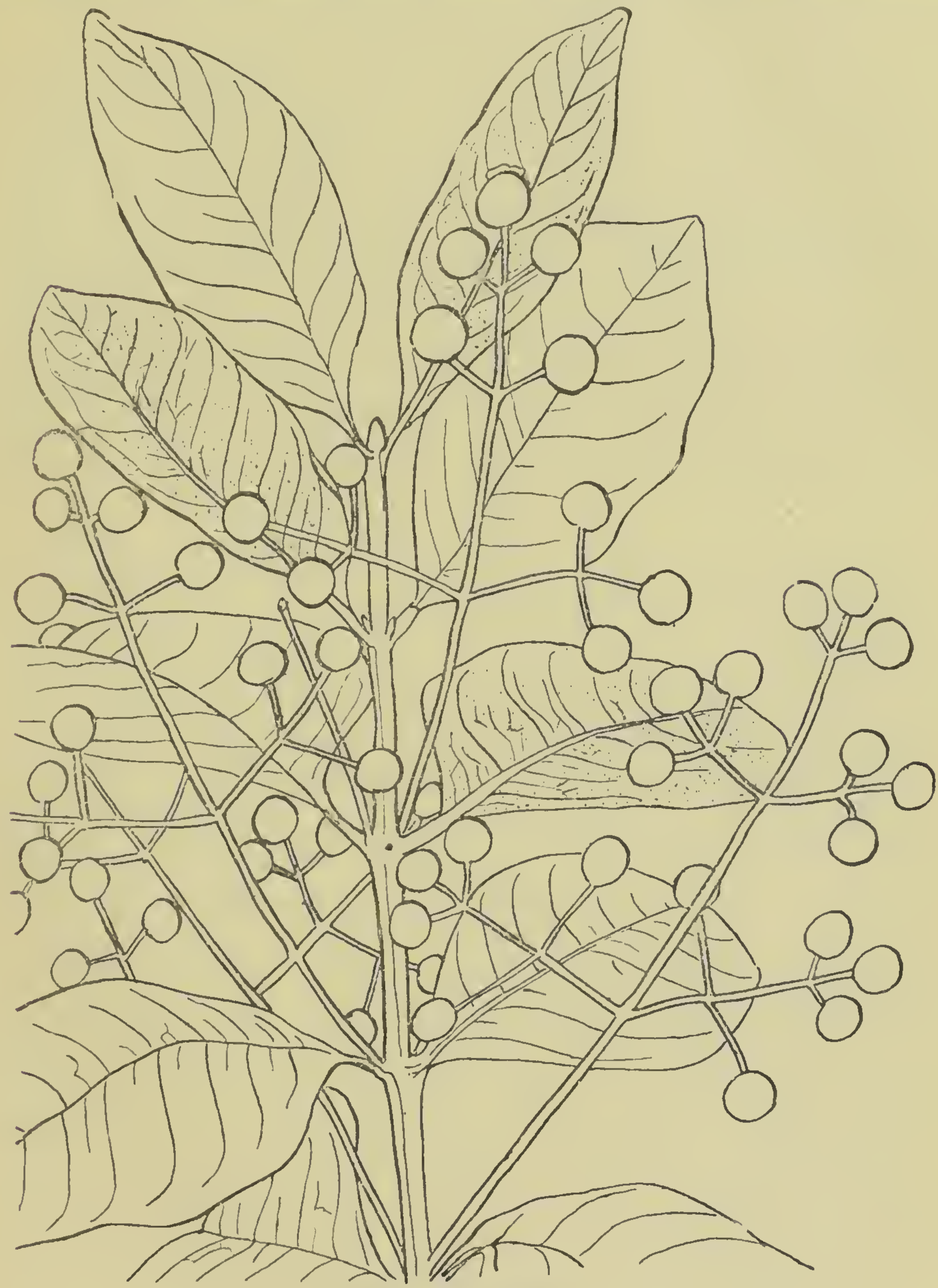
† Hort. Beng., p. 37.

‡ Dict., iv. 410.

§ Bot. Mag., 2,153.

‖ Flor. Ind., Occ. ii. p. 909.

acris, Colla* and Plunkenett.† It is allied to *Eugenia Pimenta,* but differs in the flowers being always 5-cleft. It is a handsome



Pimenta acris Wight
(reduced).

tree, 20 feet to 40 feet in height, of a pyramidal form. The leaves are opposite, without stipules, short-stalked, 2 to 3½ inches long,

* Hortus Ripulensis, p. 49.

† Almagistum botanicum, t. 155 f. 3.

broadly oval or obovate-oval, rather obtuse at the apex, entire, thick, smooth, strongly veined on both surfaces, shining above, paler and scattered with minute dots beneath.

The flowers are small, numerous, stalked, arranged in threes (the central one on a short pedicel, the two lateral on longer, widely spreading ones) at the extremities of the divaricate branches of large trichotomous axillary or terminal cymes longer than the leaves, the whole often forming one large corymbose inflorescence; branches slender, compressed, punctate with glands. In the woods of Antigua, Jamaica and Barbadoes the fragrance of the leaves of this tree fills the air. The fruit is an ovoid-globular berry, about the size of a pea, smooth, crowned with the persistent calyx-lobes, blackish when ripe, with scanty pulp, 2-celled, of aromatic smell and taste, seed solitary in each cell.

The sp. gr. of the oil of "West Indian Bay leaves" is stated by Dodge and Olcott* to range between 0·895 and 1·020, and an average sample of a complete distillation to have a sp. gr. of 0·965 at 60° F. Oil distilled in the New York factory of Messrs. Schimmel & Co. from imported leaves was found to have a sp. gr. of 0·9828 at 15° C.; the yield being 3·5 per cent. Investigations in this respect were made by Professor Markoe,† who, operating on about 7,000 lbs of leaves, imported principally from the Island of St. Thomas, obtained the following results:—"The apparatus used in distilling the oil was a 200-gallon copper still, heated by steam, so arranged that either wet or dry steam could be used at pleasure. From 200 to 300lbs. of leaves were used at each running of the still, and to work off this quantity required from eight to twelve hours, during which time from 80 to 100 gallons of distillate would be obtained. The oil comes over in two portions. First a portion lighter than water, that comes over very rapidly, and then the heavy oil, that comes over very slowly and does not easily separate from the water, with which it forms a milky emulsion. The following notes were made of one of the runs with 200lbs. of leaves. The distillate was collected in quantities of 2½ gallons of the oil carefully separated from each portion. The sp. gr. of each portion was then taken:—

* Druggist's Circular, July, 1888, p. 156.

† Pharm. Journ. [3], viii. p. 1005.

LIGHT OIL.

No. 1	....	0·870
„ 2	....	0·930
„ 3	....	0·946
„ 4	....	0·964
„ 5	....	0·982
„ 6	....	0·990

the total yield of the light oil coming over in the first 15 gallons of distillate, from which it promptly separated, leaving the water quite clear.

The distillation was then continued to obtain the heavy oil, until 65 gallons more of distillate were obtained. This oil was received in three portions and the sp. gr. of each portion then taken :—

HEAVY OIL.

No. 1	....	1·023
„ 2	....	1·035
„ 3	....	1·037

The oil when first distilled is colourless, but by exposure to the air quickly acquires a yellowish tint, which deepens into a rich brown tint, and if the exposure is continued, the oil becomes quite dark in colour just as does the oil of clove or the oil of pimento. The odour of the freshly distilled oil is rank, but in the course of from three to six months, it becomes mellow and ripens into the agreeable fragrance so much liked.

Twenty pounds of the crude heavy oil which had been exposed to the air until it had acquired a deep brown colour, were put into a 30-gallon jacketed steam still, together with 20 gallons of water. The distillation was begun very slowly, and the distillate collected in portions of 2½ gallons. The first and second portions contained about 4lbs. of light oil, then the water came over of a milk-white colour, and on being allowed to stand, the heavy oil subsided to the bottom of the bottles.

The distillation was very tedious, requiring 20 hours to get all the oil over. When the oil had separated from the water, the latter was returned to the still. 75 gallons of distillate were required to complete the rectification. The 26 portions of heavy oil were divided into thirteen portions by mixing Nos. 1 and 2 together, 3 and 4 together, and so on through the series. The sp.

gr. of each portion was then taken, and is given in the following table, at 85° F., the temperature of the laboratory.

1	1·025
2	1·030
3	1·036
4	1·040
5	1·045
6	1·045
7	1·047
8	1·048
9	1·048
10	1·048
11	1·048
12	1·042
13	1·035

The first eight portions were nearly colourless. No. 8 had a light straw colour, 9 and 10 light brown, and 13 almost black.

Nos. 8, 9, 10 and 11 being all of the same sp. gr. were mixed together and taken to represent the *pure heavy oil of bay.* It had the following properties :—Colourless when first distilled, quickly acquiring a brown colour by exposure to the air; the odour recalls that of clove; the taste, hot, pungent, aromatic, very like that of oil of cloves; it reddens the skin and produces a hot tingling sensation in the part to which it may be applied; the effect does not, however, last along. The oil is soluble in the 95 per cent. alcohol of the market in all proportions, also in ether and petroleum benzene. It is soluble in the officinal solutions of caustic potash, forming after a short time a mass of crystals.

The sp. gr. at 77° F. and at 60° F. was taken with much care, using a 500-gram flask in making the determinations :—

Sp. gr. of heavy oil of bay at 77° F.	...	1·052
" " " 60° F.	...	1·055

Ten pounds of light oil of bay, as obtained from the leaves, having a sp. gr. of 0·945 were then slowly re-distilled. The first portion of the distillate, consisting of a clear, limpid colourless liquid, had a sp. gr. of 0·829 at 77° F. and of 0·8356 at 60° F. It was found to be perfectly soluble in strong alcohol, ether, benzene and chloroform. When the residue in the still was examined, about 4 ounces of a dark coloured, very thick body, was obtained from the

sides and bottom of the still. It is carried over to some extent during the last part of the distillation.

A sample of oil distilled from leaves imported direct from St. Thomas was examined by Dr. Mittmann, in Breslau. Eugenol was found to be the principal constituent; the methyl ether of eugenol was also present in small quantity, as well as pinene and probably dipentene and diterpene. The sp. gr. at 15° C. was 0·970. The oil dissolved clear only in ether, petroleum ether, carbon disulphide and chloroform, while with alcohol and glacial acetic acid it gave a strong turbidity,* therefore, in preparing "Bay Rum" from Bay oil, the solution may prove turbid and require to be filtered through, or treated with magnesia.

In the Edition of the U. S. Pharmacopœia just published (Seventh decennial Revision) the tests for pure Bay oil have been modified in accordance with the result of the most recent investigations:—The sp. gr., which formerly stood at 1·040 has been reduced to 0·975—0·990, the higher figure having been found to facilitate adulteration with oil of cloves or pimento; the absence of these adulterants is furthermore ascertained by the following test:—

"If to 3 drops of the oil, contained in a small test tube, 5 drops of concentrated sulphuric acid be added, and, after the tube has been corked the mixture be allowed to stand for half an hour, a resinous mass will be obtained. On adding to this mass 4 c. c. of diluted alcohol, vigorously shaking the mixture and gradually heating to the boiling-point, the liquid should remain nearly colourless, and should not acquire a red or purplish-red colour; (distinction from oil of pimenta and oil of cloves.)"

It is quite unusual in a work of this sort to enter into any details of retail business, such as trade formulæ of compounds, yet the following ℞ for "Bay Rum" is so strongly recommended by a leading firm of ess. oil distillers that some readers may advantage by taking note of it.

West Indian Bay oil ...	2 drachms.
Pimento oil	1 drachm.
Clove oil	10 drops.
Alcohol (95 per cent.)...	½ gallon.
Water	½ gallon.

Mix and allow to stand for several days, then filter.

* Schimmel & Co.'s Report, October, 1889.

Another recipe is :—

Bay oil	....	1 oz.
Alcohol, 95 per cent.	....	$\frac{1}{2}$ gallon.

Mix and allow to stand for a fortnight; then add 1 gallon good Jamaica rum.

Bay oil is also largely used in Germany in the preparation of Bay rum soap. This soap possesses very refreshing properties and is likely to become very popular. The same proportions of the same ingredients are used as for the wash.

In the list of plants frequently catalogued as belonging to the genus *Myrcia*, occur several which are considered by some authorities to belong to the genus *Myrtus* of the same Natural order *Myrtaceæ*, and several species of *Myrtus* whose flowers and seeds are unknown may belong to the genus *Myrcia*.

The Natural Order *Myrtaceæ* includes about 75 genera and some 2,000 species. The species of the typical genus *Myrtus*, numbering about 100, are widely scattered, the greater number, however, being found in the mountains of tropical South America, extending into the temperate parts of Chili and even as far South as the Falkland Islands; others occur in Central Asia and New Zealand, while about a dozen species, which some botanists distinguish as a separate genus under the name *Jossinia* are confined to the Mauritius, Bourbon and neighbouring islands.

Myrica asplenifolia (see *Comptonia asplenifolia*).

Sweet Bay.

The common Sweet Bay is the *Laurus Nobilis* Lin. (Sp. Pl., Ed. i., p. 369). For figure of the plant see Stevenson and Churchill, Med. Bot. t. 125; and Bentley and Trimen, Med. Plant. t. 221.

In Greece it is very common in the forests and is extensively cultivated in the gardens of cloisters.

In England the *Laurus Nobilis* only attains the dimensions of a shrub, producing its flowers only in sheltered situations in April and May. In its native soil of Asia Minor, Syria, the countries surrounding the Mediterranean, Italy and Greece, it frequently rises twenty or thirty feet in height, but never loses its shrub-like character. It is much branched, and covered with a smooth olive-

coloured bark. Its leaves are very numerous, evergreen, lance-shaped, rather over three inches long, but varying in size, on short channelled petioles, alternate, without stipules, pointed, smooth, strongly veined beneath, entire, of firm texture, deep green colour, and covered with small immersed glands. The leaves of L. nobilis are always undulate and may at once be distinguished at sight by this character from the "garden laurel," also from the fact of its leaves being entire, and not serrate. The difference in odour when bruised is also at once apparent.

It is noticed, however, that the undulation, or crisping at the edges of the leaves varies a good deal. The width of the leaves also varies. Meissner * distinguishes five varieties on these characters. The flowers are male and female on different plants, small, yellowish in colour, and arranged in small umbellate, stalked clusters of usually five, surrounded by an involucre of blunt, concave, reddish bracts, which enclose the umbel when in bud; the peduncles are short, stout, curved, and in pairs coming off opposite one another at the axils of the leaves. The corolla in both male and female flowers is divided into four oval, concave segments, which stand erect and are of an herbaceous or yellowish white colour. The filaments are as long as the calyx: the four outer ones simple, the rest compound, bearing two lateral glands or abortive anthers. The true anthers are yellow, ovate, composed of two valves, diverging from the stamens, or gaping at the base. The style of the female flowers is very short, and the germen becomes an oval drupe, scarcely $\frac{3}{4}$ of an inch long, which is fleshy, very smooth, of a dark purple, almost black colour, and containing a large nut of similar shape. Dr. Landerer says, that in Greece the fruit resembles that of the olive, and is known by the name of Daphnekoukou, after the name of the tree *Δάφνη*.

The dried berries are sometimes imported from the south of Europe. In this state they appear of a blackish-brown colour, with a thin, brittle, wrinkled pericarp, to which the single seed is not attached. When shaken near the ear they are heard to rattle, a character which at once distinguishes them from "Cocculus Indicus" berries, which resemble them in appearance and have sometimes been mistaken for them; the seed of Cocculus Indicus is not loose in the pericarp, and cannot rattle. The seed of the

* In DC. Prodr. xv., pt. i., pp. 233-240.

Bay berry is oval, firm, and readily separated into two equal lobes. It has a bitter aromatic taste and an agreeable aromatic odour; these properties being due to a fragrant volatile oil, nearly 1 per cent., which may be obtained by distillation with water. Its sp. gr. at 15° C. is 0·924. From some samples a larger yield of oil has been obtained. The seed also contains a concrete fixed oil of a greenish colour and butyraceous consistence. This may be obtained from either fresh or dried fruits by expression; so obtained it consists of a mixture of volatile oil and fatty bodies, in the same way as does the expressed oil of nutmeg.

The leaves also yield from 0·8 to 2·5 per cent. of a fragrant volatile oil by distillation. Sp. gr. 0·924 at 15° C. This oil was imperfectly examined by Barbaglia, and the result contributed to the "Atti della Societa Toscana di Scienze Naturali," 1889. According to this observer the greater part of the oil distils off at a temperature between 170° and 175° C. He is of opinion that a partial decomposition of the oil may take place during distillation.

Examined by Messrs. Schimmel, the oils of both berries and leaves were found to contain Pinene and Cineol.

California Bay, known also by a variety of names such as Mountain Laurel, Spice-bush, Balm of Heaven, Sassafras Laurel, Cajeput-tree, Californian Olive, etc, has been described in American botanical language as *Oreodaphne Californica* (? Nees) *Laurus Californica, Tetranthera Calefornica* and latterly *Umbellaria Californica.* It is quite distinct from the "Spice bush" described at page 44, which is *Laurus Benzoin* Lin.

California Bay is common in mountainous parts of California and the Pacific slope, particularly in the vicinity of ravines and moist shady localities, attaining a height of between 50 and 100 feet in some localities. At the height of 50 feet it will have a trunk 30 inches in diameter, but in southern districts it does not exceed 20 feet in height. It flowers in June. The leaves are dark green, lustrous, four inches long, one inch wide, acuminate and very aromatic, their odour approaching to that of the Bay leaf. Dr. Palmer in the American Journal of Pharmacy, December, 1878, says that "by rubbing the hands and face a short time with the leaves, a very disagreeable headache will be produced, and that the Indians in California have been long aware of the power which this plant has to pro-

duce a headache in those who are well and to cure those who are afflicted with it." Some description of the tree was given by Heaney in 1875 at a meeting of the Philadelphia College of Pharmacy,* who states that all parts of the tree abound in volatile oil, but particularly the leaves, which contain 4 per cent. He submitted this oil to chemical examination† and found it to be composed of a hydrocarbon and an oxygenated oil which he calls *oreodaphnol*, in the proportion of one part of the former to two parts of the latter. The crude oil is limpid, of a straw colour, pungent aromatic odour and warm camphoraceous taste. It is soluble in 1,000 parts of water, mixes in all proportions in alcohol and ether, has a sp. gr. of 0·936 and burns with a bright light, smoky flame, leaving a carbonaceous residue. When inhaled it produces dizziness and headache, and is recommended for inhalation in nervous headache and nasal catarrh.

The pure hydrocarbon obtained by fractional distillation, boils at 175° C., has a sp. gr. of 0·894 at 15° C., is colourless and limpid, of agreeable aromatic odour, bearing some resemblance to a mixture of camphor and oil of nutmegs, and a taste like that of cardamom; it is highly inflammable, burning with a brilliant slightly smoky flame; is nearly insoluble in water; soluble in five volumes of 95 per cent. alcohol, and dissolves iodine slowly, acquiring a deep red colour. Nitric acid causes a violent reaction and destroys its odour completely.

Oreodaphnol, the oxygenated portion (on which the pungent odour of the crude oil depends) was obtained between 175° and 220° C. It is oily in consistence, of a light straw colour, pungent and penetrating odour, and hot camphoraceous taste. Its sp. gr. is 0·960 and it boils at 210° C. It burns readily with a bright flame, giving off pungent vapours and leaving a carbonaceous residue. When distilled with glacial phosphoric acid in an atmosphere of dry hydrogen, a light straw-coloured liquid is produced, which has a sp. gr. of 0·934, boils at 204° C., burns with a white flame and has no reaction with sodium. This liquid was named *Oreodaphnene*. The character and composition of this oil were examined by Still-

* Am. Journ. Pharm., pp. 105-109.

† The method of investigation adopted was that recommended by Frederick Rochleder in his work on "The Proximate analysis of Plants and Vegetable Substances." See also Pharm. Journ. [3], v. p. 792.

man in 1880*; his results somewhat differ from those of Heaney, quoted above. From between 60 and 70lbs. of the fresh leaves he obtained 820 grams of essential oil of a clear yellowish straw-eolour, and having the peeuliar aroma of the leaves; the sp. gr. at 11° C. being 0·940. "It does not thieken on long standing. It separates on fractional distillation into two portions, one boiling between 170° and 190° C., the other between 210° and 225° C.; smaller quantities passing over as high as 260°. The lesser fraction is mainly eomposed of a terpin-hydrate agreeing with the terpinol of Wigers, in which one molecule of water is combined with two of $C_{10}H_{16}$. It boils at 167° to 168° C., is elear, eolourless and mobile, and is not readily effeeted by metallie sodium, even when heated with it. A fraction boiling between 171° and 172° is evidently a mixture of the above with the more oxygenated, higher-boiling eonstituent $C_8H_{12}O$, of which the higher fraction (210° to 225° C.) appears to be mainly composed." Stillman gives the name *Umbellol* to the fraction "boiling without deeomposition at 215° to 216° (uncorreeted), it being a eolourless mobile liquid of aromatic and powerful odour, but not volatile at ordinary temperatures."

Myrtle.

The most generally known myrtle, *Myrtus communis* Lin. (Spee., p. 673), is by some considered to be a native of the South of Europe, on exposed rocks. It is extremely abundant in Italy, Southern France and Spain. By others it is not considered to be indigenous to Europe, but only naturalised, having originally been brought from Western Asia, where, at the present day it is found in a wild state as far east as Afghanistan.

It grows in the form of a large bushy shrub, from 3 to 10 feet in height. It is admired for the fragrance and elegance of its shining evergreen leaves and for its sweet-seented flowers, and was a great favorite with the aneient Greeks, who called it *μυρτος*, a word derived from *μυρον*, perfume. In England it is not sufficiently hardy to withstand the frost of severe winters, although in the extreme southern parts it frequently survives long enough to attain its full growth. The leaves are ovate or laneeolate, aeute, opposite, entire, and marked with transparent dots. The flowers are white, single, on solitary pedieels, about

* Am. Journ. Pharm., 1880, pp. 315-318; and Am. Chem. Journ., April, 1880.

the length of the leaves. The pedicels bear two linear bracteoles under the flowers. The calyx is 5-cleft. The seeds are reniform. The embryo is arched, with a long radicle, and small equal cotyledons.*

The essential oil of myrtle was first examined by Gladstone, 1867,† with the result that three-quarters of the specimen operated on distilled over between 160° and 176° C., leaving a reddish brown residue, which evolved sulphuretted hydrogen. The rectified distillate proved to be a hydrocarbon of rather high sp. gr., with an odour resembling that of the hydrocarbon from Bay. Messrs. Schimmel record the sp. gr. to be 0·89 to 0·92 at 15° C., and that it is composed of Pinene, Cineol and Dipentene.

Under the name of "myrtol," an oil described as the portion boiling between 160° and 170° C. has been introduced into commerce as preferable for medicinal purposes to the crude oil, an assertion which induced Herr E. Jahns, of Gottingen, to investigate both the essential oil and this "myrtol," with a view of ascertaining to which constituent the medicinal properties are referable.‡ The sample of oil used, described as "Spanish," was pale yellow, of sp. gr. 0·910 at 16° C., and strongly dextrorotatory. This oil began to boil at 160° C., and about 80 per cent. distilled between that point and 240° C. Upon fractionation there were obtained :—

1°—A turpene, $C_{10}H_{16}$, boiling at 158-160° C., corresponding to a right-handed pinene.

2°—Cineol, $C_{10}H_{18}O$, boiling at 176° C.

3°—A very small quantity of a camphor, probably corresponding to the formula $C_{10}H_{16}O$.

Considering the compound nature of this "myrtol," it would be better described as "rectified oil of myrtle." Herr Jahns is of opinion that the reputed medicinal value of myrtle oil and myrtol depends upon their strength in cineol, which body has been shown to be identical with cajeputol and eucalyptol, and he suggests that instead of such a mixture (dextrogyre pinene, cineol, and dipentene), pure eucalyptol should be prescribed, or if the presence of terpene is thought desirable, a mixture of eucalyptol with rectified

* Gærtn. Fruct., i. p. 184, t. 38 ; Lam. Ill. t. 410.

† Journ. Chem. Soc., xvii. 11.

‡ Archiv. der Pharm., 1889, p. 174.

turpentine would be equally efficacious and much cheaper than the essential oil of myrtle leaves. But in most cases it would be desirable to avoid the irritating action of the turpene upon the respiratory organs.

Interesting observations concerning the action of myrtol on micro-organisms have since been made by Dr. Braütigam and Dr. Nowac, copious notes of whieh appeared in the "Pharmaceutische Zeitung," 12th April, 1890.

As an aromatie astringent and as a remedy in cases of bronchitis, attention has been drawn to the oil of Myrtus Chekan (which see).

The effects of oil of myrtle on the human system when taken internally were observed by Linarix,* one remarkable result being, that in the rapid passage of the oil through the system, whieh commences within a quarter of an hour of the administration of a dose, the urinary exeretion acquires a strong *perfume of violet*, —a peeuliar effect whieh is also observable in some patients after administration of oil of turpentine. Apropos of oil of myrtle exhibited in this respect, Linarix remarks :—" Donné à des malades qui rendaient des urines infeetes, ee médieament a eoupé court ce phénomène."

An essential oil and highly perfumed water, known as " Eau d'Ange " is distilled from the flowers of myrtle.

The fruits, whieh have a sweetish, powerfully aromatic taste, are eaten in a fresh state, or dried and used as a eondiment.

Several varieties of *Myrtus communis* exist, some of whieh are constant, such as :—

Var. Melanocarpa (D. C. prodr. iii. p. 239); fruit blackish. This variety is frequent in the South of Europe, and in gardens, where there are varieties of it with double flowers and variegated leaves.

" *Romana* (Mill. Dict. t. 184 f. 1); leaves ovate; pedicels longer. The common " Broad-leaved or Roman myrtle." It is sometimes called " Flowering myrtle " because it flowers more freely in England than any other variety.

" *Tarentina;* the " Box-leaved myrtle " (Mill. Diet) leaves ovate, small; berries rounder; flowers small and open late in the Autumn.

* Thèse pour le doctorat, Paris, 1878, "Journal de Thérapeutique."

Var. Italica; the "Italian or upright myrtle" (Mill. Dict.); leaves ovate-lanceolate, acute; branches more erect.

„ *Bætica;* the "Orange-leaved myrtle" (Mill. Dict.); leaves lanceolate, acuminate.

„ *Lusitanica;* the "Portugal myrtle" (Lin. Spec. syn. *M. acuta*, Mill. Dict.; Clus. Hist., i. p. 66 f. 1.); leaves lanceolate-ovate. The Nutmeg myrtle" appears to be only a variety of this.

„ *Belgica;* the "Broad-leaved Dutch myrtle" (Mill. Dict.); leaves lanceolate, acuminated, crowded. The "Double-flowering myrtle" appears to be of this variety.

„ *Mucronata;* the "Rosemary or Thyme-leaved myrtle" (Lin. spec.; syn. *M. minima* Mill.); leaves linear-lanceolate, acuminated.

„ *Leucocarpa* (D. C. prodr. iii. p. 239; Smith, prodr. Flor. Græc., p. 36). Fruit white, rather large, edible, with a grateful taste and smell. Native of Greece and the Balearic Islands.

There are other varieties in gardens which are less constant in their distinctive characters than the above, such as:—

Gold-striped broad-leaved myrtle.
Broad-leaved Jews' myrtle.

This variety has its leaves frequently in threes, on which account it is said to be in esteem among the Jews in their religious ceremonies.

Gold-striped-leaved orange myrtle.
Silver-striped Italian myrtle.
Striped box-leaved myrtle.
Silver-striped rosemary-leaved myrtle.
Silver-striped nutmeg myrtle.
Cock's-comb or birds' nest myrtle.
Spotted-leaved myrtle.

All the species of myrtle grow well in a mixture of sandy loam and peat, and cuttings, not too ripe, strike root readily in sand or mould.

Myrtus Chekan, Spreng, is an evergreen shrub, from four to six feet high, indigenous to the central provinces of Chili, where it grows abundantly, forming a kind of underwood in all the quebradas

or ravines which follow the course of the small streams. In general character, the plant bears a strong resemblance to the common myrtle (*Myrtus communis*) ; it is much branched, the leaves are evergreen, opposite, entire and smooth, oval-lanceolate in shape, from one-half to two-thirds of an inch long, and about half as broad, tapering towards either end, the largest leaves not being more than one inch long and eight lines broad. The flowers are white and resemble those of the common myrtle in appearance; they are solitary in the axils of the upper leaves; when these fall off, as they sometimes do, the flowers have the appearance of being arranged in terminal racemes or cymes.

It is believed that the plant was introduced into this country by Messrs. Veitch & Sons in 1862 ; a figure of the plant from a specimen which flowered at Kew, was published in the Botanical Magazine in July, 1866 (tab. 5644). The flowers differ from those of the common myrtle in having only four petals, which, as well as the sepals, are more rounded and ciliate on the margin. The leaves also are shorter and broader in proportion.

Under the name of Chekan, Chequen or Cheken, the plant has long been known and used medicinally in Chili in cases requiring an aromatic astringent of considerable power, and a large quantity of the leaves were imported into England a few years ago, with a view to their trial by the medical profession here, the properties being extracted in the form of infusion, fluid extract and syrup, also in cases of bronchitis, by inhalation of the vapour.

The leaves of *Myrtus Cheken* were submitted to a thorough chemical investigation by Herr Weiss.* Upon distillation, the leaves yielded about 1 per cent. of a thin, pale greenish-yellow, dextrogyre oil, having an aroma closely resembling that of common myrtle oil. Its sp. gr. was found to be 0·8795 at 15°C. It was miscible in all proportions in absolute alcohol, ether and chloroform. Upon fractionation, this oil was found to consist of:—

About 75 per cent. of a terpene $C_{10}H_{16}$, apparently identical with Pinene, and boiling at 156°-157°C.

About 15 per cent. of an oxygenated constituent $C_{10}H_{18}O$, identical with Cineol, boiling at 176°C.

About 10 per cent. of a mixture passing over between 220° and 280°C, which was not nearer examined.

*Archiv. der Pharm., Aug., 1888, p. 665.

The leaves, after the separation of the oil, yielded about 15 per cent, of alcoholic extract, from which were separated :—

1°—*Chekenon* $C_{40}H_{44}O_8$, crystallizing in yellowish, odourless and tasteless 6-sided prisms, soluble in alcohol, ether, chloroform, benzene and acetic acid, and insoluble in water.

2°—*Chekenin* $C_{12}H_{11}O_3$, crystallising in odourless and tasteless yellowish rhombic tables, freely soluble in hot alcohol and ether, and difficultly soluble in cold alcohol, acetic acid, benzene, petroleum-ether and water.

3°—*Chekenetin* $C_{11}H_7O_6 + H_2O$, obtained in yellowish, almost olive-coloured crystals, probably allied to *quercetin.*

4°—"Cheken-bitter," an amorphous substance, soluble in most solvents, and to which the bitter taste of Cheken leaves is attributed.

Lindera.

An odour somewhat approaching to that of Myrtle has been noticed in the oil of *Lindera sericea* Blume, a Lauraceous shrub indigenous to and widely distributed in Japan, where it is known under the name of "Kuro-moji," by reason of the blackish colour of its bark. An essential oil distilled in Japan from the wood is reported* to have a very fine aromatic and balsamic odour, and might be useful in perfumery, especially as it is not expensive. Its sp. gr. is 0·892 at 15° C. It is composed of Limonene, Dipentene, Terpineol and Carvol. A sample separated by distillation into three fractions gave :—

1°—A fraction boiling between 180° and 200° C., having an agreeable odour of myrtle and coriander.

2°—A fraction boiling between 200° and 220° C., of an agreeable balsamic odour, recalling somewhat lign-aloe oil, but finer and more fragrant.

3°—A portion boiling between 220° and 240° C., resembling the carvol contained in curled mint.

This essential is imported into Europe from Japan under the name of "Kuro-moji" oil, and is said to be coming rapidly

* Schimmel and Co., Berichte, April, 1889.

into favour. According to the investigations of Kwasnick,* the oil distilled from this wood is of a dark yellow colour, and has a powerful aromatic odour; its sp. gr. is 0·901 at 18° C. and 0·896 at 20° C. In a column of 100 m. m. it exhibits a lævo-rotary power of 0°.4. It forms a clear solution in alcohol, ether, benzene, petroleum spirit, glacial acetic acid or fat oils. Two terpenes were detected in it, viz., dexto-rotatory limonene and dipentene. Of oxygenated bodies, terpineol and lævo-carvol were found.

Another variety of this shrub is called "Shiro-moji," by reason of its greyish-white bark. In both kinds the white pith is surrounded by a greyish-white silky-looking wood, having an agreeable odour. This wood, which in transverse section shows delicate medullary rays, distinct annular rings, and very fine pores, is the bearer of the essential oil.

Kapur-Kachri.

The product bearing this name in the Hindee, Bengalee and Bombay dialects and valued as a perfume in the East, especially by the Arabs and Persians, and used by the Hindus as incense in worship, consists of the dried root of *Hedychium spicatum*, Smith, figured and described in the Botanical Magazine, t. 2,300, and in Loddige's Botanical Cabinet, t. 653.

The word *Hedychium* is derived from ηδυς, *sweet*, and χιων, *snow*, in allusion to the fragrance, elegance and whiteness of the flowers of the original species *(H. coronarium)* of this genus of *Zingiberaceæ*, all of which are handsome plants with tuberous, herbaceous stems, clasping leaves, and a terminal spicate inflorescence.

H. spicatum is a native of Nepal and Silhet. Dr. Stewart† says it is not uncommon in the Punjab Himalayas up to near the Jhelam at least, at from 3,500 to 7,000 feet.

Dr. Dymock, in his Notes on Indian Drugs, says that this dried root forms a considerable article of commerce in India and China, and is also exported to Europe. Two

* Archiv. der Pharm., xxx. p. 265; and Ber. Deutsch Chem., Ges., xxiv. p. 81.

† Punjab plants, p. 239.

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HEDYCHIUM SPICATUM

(REDUCED).

A.—Section of dried root as found in the Chinese market.
B.—The flat starch-granules of the root, seen in face and edgeways.
C.—The characters used in Szechuen Province to designate this drug.
D.—The characters used in Kiangsu Province.

kinds are found in the Bombay markets, viz., the Chinese and the Indian; the latter was supposed by Royle to be the "Lesser Galangal" of Ainslie* called "Sittarittee," but Modeen Sheriff states that the sittarittie of the Tamils is the true lesser galangal, which statement appears to be correct. The root of Indian Kapur-Kachri when entire is reddish-brown, marked with white rings, bearing considerable resemblance to the true "Lesser galangal," whence, perhaps, the confusion of names. M. C. Cooke† says, "It differs from Galangal in being very white and friable, internally starchy in structure, fragrant, slightly warm and aromatic in taste, but not peppery or pungent. Its peculiar, strong odour is at any time almost of itself sufficient to identify this drug; it is an odour never to be forgotten, and not to be confounded with any other." Dr. Thresh describes the odour as intermediate between Storax and Rhubarb, and Dr. Dymock to that of orris, but more powerful, and strongly camphoraceous. This last authority describes the appearance of the drug as met with in the Indian market as follows:—It occurs in slices, mostly circular, but sometimes the section is made in a sloping direction. The slices are half to three quarters of an inch in diameter, and vary much in thickness, from one-fifth to three-eighths of an inch; they are white and starchy, and when freshly pared exhibit a faint line dividing the cortical from the central portion. The edges of each slice are covered by a tough reddish-brown bark, marked with numerous scars and circular rings; here and there rootlets remain attached.

Chinese Kapur-Kachri is a little larger than the Indian, white, and less pungent. The bark is smoother and of lighter colour. A microscopic examination of the Indian rhizome shows it to consist of a delicate parenchyma, most of the cells of which are loaded with large ovoid starch granules, partaking of the character of Curcuma arrowroot, except that they are somewhat smaller; that is, they are ovate or elliptical, rather regular in outline, but flattened, so that when seen sideways they are lenticular, with rounded ends. At first, a mounting of this starch seems to consist of two kinds of starch mixed together, but a few moments' examination proves that the narrow granules are only the broad

* Mat Med. Ind., i. p. 140.

† Pharm. Journ. [3], i. p 603.

ones set on edge. A few of the cells contain resin and essential oil. The epidermis is composed of several rows of compressed, nearly empty, reddish-brown cells. From the unaltered condition of the starch it appears that the rhizomes are not exposed to heat in drying.

A chemical examination of the root was made by Dr. Thresh* which proved that the odorous principle exists but in very minute proportion, and to isolate it in a state of purity would necessitate working on a large quantity of material; but in the state in which he did eliminate it, combined with a small quantity of fixed oil, it was very powerful. He says, "a very small quantity being dropped upon the clothes, renders them highly odorous for a considerable length of time, or if exposed, causes a large room to be pervaded with an odour recalling that of hyacincths." Describing the method of extraction, he says that the odorous principle was entirely taken up by petroleum ether. Dry ether exhausted the rhizome more readily, but extracted little or nothing which was not soluble in the petroleum, and as certain constituents of the plant were found to be more readily isolated from the petroleum solution, the whole of the sample was treated therewith. Upon allowing the petroleum ether to evaporate slowly, an abundant crop of large, colourless, tabular crystals was obtained, together with a pale yellowish-brown oily fluid. These crystals, after washing with cold petroleum, were submitted to a series of re-crystallizations in order to remove traces of the odorous matter. They were finally quite odourless, and found to possess the following properties:—Soluble in petroleum ether, ether, alcohol, chloroform and benzene. Insoluble in diluted solutions of potash, soda or ammonia. Sulphuric acid dissolved it in the cold without production of colour, but if heated the solution became purple red. The alcoholic solution was neutral in reaction, not coloured by ferric chloride or precipitated by basic lead acetate, neither did it reduce silver salts. The melting point was found to be 49° C., and after melting it would remain fluid at ordinary temperatures for days if left undisturbed. The vapour density could not be ascertained, as it was found that at the temperature necessary to vaporise it, dissociation took place. By combustion with oxide of copper in a current of oxygen, the

* Pharm. Journ. [3], xv. p. 361.

empirical formula was found to be $C_{12}H_{14}O_3$. Dissolved in alcoholic potash and warmed, the solution, if strong, almost instantly becomes filled with minute nacreous crystals, and the whole at once dissolves when diluted with water. Upon distilling the solution nothing but ethyl alcohol was found in the aqueous distillate. The faintly coloured solution left in the flask gave an exceedingly voluminous white precipitate when acidified. The acid thus separated was found to agree with the formula $C_{10}H_{10}O_3$, and as this acid was the only product of the saponification discoverable in the alcoholic solution, the formula of the crystalline principle rendered it very probable that it was the ethyl salt of this acid. Dr. Thresh's further researches lead him to the conclusion that the acid he obtained from *Hedychium spicatum* is identical with the acid prepared by Perkin, by the action of acetic anhydride on anisic aldehyde in presence of sodium acetate, viz., *Methyl-paracoumaric acid*, of the same constitution, $C_{10}H_{10}O_3$.*

The proximate analysis of the rhizome of *Hedychium spicatum* gave the following results :—

Soluble in Petroleum ether—		
Ethylmethylparacoumarate	3·0	5·9
Fixed oil and odorous body	2·9	
Soluble in alcohol—		
Neutral substance precipitated by tannin		2·7
Acid, resin, &c.		
Soluble in water—		
Glucoside or saccharine matter		1·0
Mucilage		2·8
Albuminoids, organic acid, &c		1·9
Starch		52·3
Moisture		13·6
Ash		4·6
Cellulose, &c		15·2
		100·0

It does not appear that the roots of other species of Hedychium have been examined, but the flowers of several of them are remark-

* Paracoumaric acid was obtained by Hlasiwetz by boiling aloes with dilute sulphuric acid ; the yield being 1 to 1·5 per cent. Ann. Chem. Pharm. cxxxvi. p. 31.

able for their perfume; the following are the most interesting on that account :—

Hedychium Coronarium, described under this name by Linnæus. Sp. pl. ed. Willd. i., p. 10; König in Retz. Obs. fasc. 5, p. 73; Roxb. Flor. Ind. i. p. 9; Bot. Mag. t. 708.

Synonymous with *Gandsulium*, Rumph. Amb. v. p. 175, t. 69 f. 3; Lamarck Ency. ii. p. 603. Called by the Bengalees Goruknatha, also Dulala-champa.

This handsome species is a native of various parts of Bengal and the neighbouring provinces, and is much cultivated for the sake of its large, very fragrant blossoms, which commence to open during the rains and continue in great profusion for a length of time. They are pure white, from 2 to 4 forming to each bracte, but seldom more than one or two of them expand at the same time. A variety deeply tinged with yellow is found in some of the interior provinces and another of a pale yellow colour; all are equally fragrant.

The root is horizontal, perennial, round, about as thick as a man's thumb, fleshy, marked with annular cicatrices. The stems are erect, 3 to 4 feet high, round, everywhere covered with the sheaths of the leaves. The leaves are from 9 to 12 inches long and about 2 broad, sessile, alternate, bifarious, lanceolate, tapering to an evanescent point; of a deep green and smooth above; striated and pale below and slightly covered with depressed, soft, white hairs. The sheaths are smooth on both sides, striated, terminating in a ligulated process (as in many of the grasses) which is often 2-parted. Spike terminal, solitary, erect, linear-oblong, about the size of the thumb, compactly imbricated, with many large, oval, concave, green, common, permanent bractes. The flowers are as above described. Bractes: besides the common exterior ones already mentioned, there are as many interior as there are flowers in the fascicle; the largest of which is about half the length of the common bracte, and envelopes not only the most forward (exterior) flower, but all those of the same fascicle gradually diminishing in size; all have a sheathing base, are membranous and striated. The calyx is superior, one leafed, a little inflated, contracted at the mouth, a little hairy, striated, and half the length of the tube of the corolla. The tube is long and slender, from the apex of the exterior bractes, recurved. The corolla is one-petaled. Border

flat, double. Exterior, 3-parted; divisions equal, lanceolate, acute, membranous, striated. Interior resupinate, 3-parted; lower two divisions obliquely oval, short-clawed; upper division broad, obcordate, banner-like, with the fissure deep and the lobes roundish; margins waved; towards the base tinged yellow. Nectary, two short fleshy subulate bodies embracing the base of the style. Filament from the lower margin of the mouth of the tube, between the insertions of the inner border of the corolla, ascending; upper side channelled for the style and inserted into the anther a little above its base. Anther, linear, sub-erect, 2-lobed. Germ obsoletely 3-sided, 3-celled, with many ovula in each, attached to the axis. Style slender, in length sufficient to elevate the large, hairy, perforated, glandular, green stigma just above the apex of the anther. Capsule oblong, 3-celled, 3-valved, opening from the apex; inside orange-coloured. Seeds, many in each cell, invested in their proper multifid, crimson aril. Integuments two. Perisperm and vitellus together conform to the seed; the former occupies the lower and exterior portion; the latter the upper and interior portion and is in immediate contact with the embryo. Embryo, simple, sub-cylindric, nearly as long as the seed.

Hedychium flavum, Roxb. Flor. Ind. i. p. 81; Edwardes Bot. Reg. t. 3039; Loddiges Bot. Cab. t. 604. A native of the valleys between the hills near Silhet, where it is called *Kattia-rityam* by the natives. It resembles *H. coronarium* in many respects, but its root, stems and leaves are larger. Dr. Wallich's annotation to the "Flora Indica" remarks that it differs from *H. coronarium* in regard to its flowers, which are yellow and about one-third smaller, having the inner segments of the corolla linear-clavate, the fissure of the lip narrow, with straight sides, and its base contracted into a linear claw. They possess the peculiar fragrance of the *Michelia Champaca* but in a less powerful degree.

Hedychium angustifolium, Roxb. Flor. Ind. i. p. 11 and Roxb. Flor. Ind. inedita Coromandel Plants, iii. t. 251. In Bengalee vernacular *Bhoo-ada.* Native of Chittagong, Silhet and the eastern parts of Bengal, where it flowers about the beginning of the rains, in June. In many respects it resembles other plants of the genus. Its flowers are in fascicles, generally three-fold and spreading out considerably from the rachis. When first expanded

they are of a delicate light buff, which changes to a red-orange, but hardly to a scarlet colour, except the stamen. They are fragrant, though of a different scent to *H. coronarium.**

Hedychium gracile, Roxb. Flor. Ind., i. p. 12 is a slender species about three feet in height, distinguished from *H. angustifolium* by its solitary-flowered spike, white corollas with scarlet filament and broader leaves. There is a variety of this with cream-coloured flowers.

Hedychium villosum, Wallich, is a native of the mountains north-east of Bengal. Its Khasee name is *Kattia Ram Rait.* This beautiful species differs from *H. gracile* Roxb. in the length and villosity of its spikes, its copious fascicled flowers, and the equal length of all the segments of the border, being altogether a larger plant. Its pale, yellow flowers are delightfully fragrant *even when dry*, an interesting character which deserves space to detail Wallich's complete analysis:—Stems upright, slender, smooth, as well as the leaves, height from 2 to 3 feet. Leaves flat, lanceolar-oblong, elevated from the back of the sheaths by a very short petiole, glaucous beneath. Sheaths terminated by an oblong, obtuse, closely adpressed, long ligula. Spike terminal, erect, cylindric, obtuse, from 10 to 12 inches long; all its parts covered with a short seriaceous down. Bractes oval, much shorter than the tube, of a reddish tint, exterior or common, 3-flowered (seldom 2), flat; interior bractes one to each flower, the base of which it embraces. Flowers as above described but less succulent than those of *H. coronarium* and *angustifolium.* Calyx very slender, somewhat shorter than the filiform tube, which is 1½ inches long; mouth obliquely bifid. Border smooth; segments linear, sub-clevate, spreading, half the length of the tube; divisions of the claw or superior segment of the inferior border, linear-oblong, obtuse. Filament as long as the tube, filiform, smooth, scarlet; anther very short, ovate, 2-lobed. Germ densely villous; stigma slightly ciliated.

Other fragrant species of Hedychium are **H. speciosum**, Wallich; Roxb. Flor. Ind. i. p. 13, with pale yellow flowers, a native of the same countries as the preceding, called in the Khasee vernacular, *Kattia Lung Matti.*

* *Hedychium coccineum*, Smith, in Rees' Cy., very much resembles *H. angustifolium*, but is recognised by Wallich in his annotations to Roxb. (Flor. Ind. i. p. 82) to be a distinct species.

H. Acumenatum, Roscoe, Edwardes Bot. Reg. t. 2969.

H. flavescens, Wallich; Bot. Mag., t. 2378; Loddiges Bot. Cab., t. 723; a species equal (though different) in fragrance to H. coronarium and H. flavum.

All the species are of easy culture in their native hot climate; they require a rich loamy soil and a plentiful supply of water in the flowering time (which, in their native habitat is the rainy season). Propagation is effected by dividing the roots. Probably new varieties could be obtained by growing from seed, but it is not recorded that this has been done.

Zedoaria.

Curcuma Zedoaria, Roxb. or "Round Zedoary," Syn. *Curcuma aromatiea,* Roscoe.

The genus *Curcuma* of the Natural Order *Zingiberaceæ,* consist of plants with perennial root-stocks and annual stems. The tubers of some of the species, such as *C. Zedoaria, C. Zerumbet* and *C. rubesecns,* are very agreeably fragrant, and in the pulverised state are used as an ingredient, together with cloves, cardamoms, Deodar, and other aromatics, in the compound called by the Hindus "*Abir,*" and by the Bengalees, "Phag";* the Abir most generally used, however, contains the root of *Hedychium Spicatum* (*q. v.*) instead of Zodoary, combined with santal wood. The rhizomes of *C. Zodoaria* constitute one of the most important articles of native perfumery, and Ainslie† states that the native women much prize those of the *C. aromatica,* as "they extract from it a colouring matter which, applied externally, imparts a particularly lively tinge to their naturally dark complexions and a delicious fragrance to their whole frame." The word *Cureuma* is derived from the Persian *Kurkum,* a name which is applied to Saffron in allusion to the colour; Turmeric being yielded by *eurcuma longa.* Watts‡ remarks that the odour of *C. Zedoaria* is "strongly camphoraceous" and "not so disagreeable as turmeric;" thus it is again instanced that taste in colours and odours varies considerably with the peoples of different nations.

* See Series 1., p. 25.

† Mat. Med. Ind., i. p. 492.

‡ Dict. of Economic plants of India, ii. 657.

The oriental synonyma of *C. Zedoaria* are as follows :—(presuming it to be the plant mentioned by Dr. Roxburgh on p. 23 of the Serampore Ed. of his "Flora Indica," and that it is the *C. Zedoaria* also mentioned in his paper in the Asiatic Researches xi. p. 333) :—

Arabic—Jedwar or Zedwar (Geiduar of Avicenna).
Bengalee—Banhaldi (in As. Res.) ; Junglee, or Bun Huldi (Wild turmeric) (in Flor. Ind.).
Sanskrit—Nirbishá, Apavishá, Vishahá (in As. Res.) ; Vunahuridra, Sholee, Vunarista, and Sholika (in Flor Ind.).
Hindee—Nirbisi, Nirabisi.
Malabar—Cuwa.
Malay—Tomon.

Roxburgh's observations are to the effect that this beautiful species is native, not only of Bengal, and common in gardens about Calcutta, but is " also a native of China and various other parts of Asia and the Asiatic islands."

The roots are tuberous, biennial, and inwardly of a rather deep yellow colour, approaching to that of turmeric. The stem consists solely of the sheaths of the leaves, which are petioled, broad-lanceolar, entire, the under surfaces being covered with a soft seriaceous down, which is particularly conspicuous when the leaves are dry. The scape rises distinct from the leaves during the dry season, and often not only at some distance, but also some time before them ; it is round, as thick as a man's forefinger, a few inches in length, and embraced by its own short, proper, green sheaths. The spike is from 6 to 12 inches long, covered with imbricated, oblong concave bractes, connected by the lower half of their margins to the backs of those immediately above, forming as many pouches as there are bractes ; the lower half of these are broad, shorter, scarcely tinged with red, containing three or four sessile flowers which expand in succession. The corolla is one-petalled, tubular at the base ; the tube being short, widening a little, and shut in the mouth with fine yellow pubescent glands. The border is double, presenting on the exterior three pale pink-coloured, erect, oblong divisions ; the upper one more pointed and incumbent over the anther and part of the two upper divisions of the inner border. The interior is three-parted, fleshy, yellow ; the lower lobe or lip longest, obovate, entire, projecting with a crown

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and erect margin, while a broad elevation of a deep yellow colour runs along its middle; the upper two divisions are obovate, and with the upper segment of the exterior border forming a complete covering or dome over the anther, The filament is short, inserted between the two upper divisions of the inner border of the corolla. The anther is two-lobed,each ending in a long sharp spur at the base. The germ is beneath, hairy, three-celled, with many ovula in each cell. The style is filiform. The stigma three-lobed, with a perforation in the centre.

The flowering time is the hot season; the plant is then highly ornamental,few surpassing it in beauty; at the same time it possesses a considerable degree of delicate aromatic fragrance. It is not uncommon to find the large rosy tufted spikes rising from the naked earth before a single leaf is to be seen. The plant is figured in Curtis' Botanical Magazine, t. 1546.

The root of *Curcuma Zedoaria* yields on distillation 1·3 per cent. of volatile oil.

The **Curcuma Zerumbet**, Roxb., is a plant of very similar nature to the *C. Zedoaria*; Watts* says they are synonymous, but the distinctive differences are clearly indicated by Roxburgh, whose botanical analysis is given below. He states the Oriental appelations to be as follows:—

> Sanskrit—Shutee; Gundha-molee; Shud-grunthhika,Kurvoora, Kurchoora, and Pulasha in the Flora Indica; and Carchuráca, Carchura, and Sat 'hi (which is also the Bengalee name) in the "Asiatic Researches" (where the words are somewhat differently Romanised from the Sanskrit character). In the Hindee, Tellingu and Bengalee dialects it is called Kuchoora.

Some writers on Indian Materia Medica hold that true Zedoary is the produce of *C. Zerumbet* Roxb., and state its Tellingu name to be *Keechlie-gudda*, and its Tamul name *Pulang-Kilunggu*.†

The Malabar name Cuwa or Kua is given by Van Rheede, who figures and describes the plant in his "Hortus Malabaricus," xi. p. 13, t. 7. (The same Malabar name is applied to *C. Zedoaria*.)

The Persian and Arabic name Zerumbad is used by Rumphius

* Dict. of the Economic plants of India, ii. p. 669.

† Ainslie, Mat. Med., i. pp. 492, 493.

in his description and figure in his "Herbarium Amboinense," v. p. 168, t. 68. With the exception of the final letter being a *t*, it is the same word as used by Garcias. The Malay name Tomon is also used by Rumphius both to this plant and to *C. Zedoaria.*

The Hindu name is given as Cachur, Cachárá and Kuchoora.

It is a native of Chittagong, from which place the Bengal supply is derived. Roxburgh's description of this plant states that the root consists, as in all other species of this genus, of ovate bulbs, giving support to the parts above ground; from their opposite sides spring the palmate tubers; these two sorts are inwardly of a pale yellow, or straw colour, and possess an agreeable camphoraceous smell, and warm, bitterish, spicy taste.

The proper fibrous roots issue chiefly from the bulbs; some of them are thicker than others, penetrate deeper into the soil, and end in an oblong, pearl-coloured, solid tuber, which is spongy and less fragrant when cut than the bulbs and palmate tubers. The stems are as in *C. Zedoaria*; the height of the whole plant being from three to three-and-a-half feet. The leaves are from four to six together, sub-bifarious, and a rather long, winged petiole intervenes between each and its stem-forming base. The leaf itself is one to two feet in length, broad-lanceolar, fine-pointed and smooth on both sides, marked with numerous fine parallel veins; constantly a dark purple cloud runs down the centre. The scape rises distinct from the leafy stems, being five or six inches long, and surrounded with a few obtuse, lax, green sheaths of various length. The spike is tufted, four or five inches long, and exactly as in *C. Zedoaria*; the superior half of the large coloured ones, which, from the tufts, are generally sterile, and of a deeper crimson or purple colour than those which contain flowers. The calyx is scarcely one-third the length of the corolla, and is irregularly three-toothed. The corolla is funnel-shaped. The tube a little curved. The border double, exterior three-parted, the two lateral segments equal, the third or upper one vaulted and crowned with a subulate point; colour a very faint yellow. The interior is three-parted; lower segment or lip broad, deep yellow, projecting, recurved, bifid; the upper or lateral segments obovate, equal, pale yellow, nearly as long as the lip. The filament, anther and germ are as in *C. Zedoaria.* The style is slender at the base, embraced by two nectarial filaments. The stigma is two lobed, crowning the anther.

The smooth oval capsule is of a pale straw colour; three-celled, but without any regular division into valves; when the seeds are ripe the elasticity of the segments of the arils bursts the vertex into various portions, from whence the seeds are soon expelled. There are several arilled seeds in each cell, varying in shape, but generally oblong. The aril is cut to the very base into several slender, unequal, white, fleshy segments, which are united to the seed round the umbilicus. The perisperm is pure white, hard and friable, occupying the lower half of the seed. The vitellus, forming or occupying the upper half of the seed, is less white and of tougher consistence than the perisperm. The embryo is nearly as long as the seed, tending to clavate, it has both ends truncate, the upper half lodged in the vitellus, and the lower in the albumen or perisperm. This plant is figured in Curtis. Botanical Magazine, t. 2000, and in Jobel und Kunze, pt. ii., t. xxiv., figs. 3, 4.

Dr. Dymock asserts in his "Notes on Indian Drugs,"* that the drug known in the Bombay Market, and supplied from the Madras Presidency as "Kachoora" (in the Hindi, Bengalee and Bombay dialects) is the produce of common *Curcuma aromatica*, "the plant which yields the Round Zedoary of Guibourt,"† and which is above described as *C. Zedoaria* Roxb., but the vernacular name mentioned by Dymock for this drug "Kachoora" is the name quoted by Roxburgh for the root of *C. Zerumbet.* Dymock states however that the specimens of the root he examined agree with the description given by Guibourt of the "round" Zedoary. Referring to the 7th edition of Guibourt, ii. p. 210, we find the statement that Zerumbet is really the "round" Zedoary, as was formerly averred by Serapion, Pomet, and Lemery. Whichever root it was which Dymock examined, he says it agrees exactly with the following description, but it is often cut into transverse slices instead of into halves and quarters:—"The round Zedoary is greyish-white externally; heavy, compact, grey and often horny internally, having a bitter and strongly camphoraceous taste, like that of the long Zedoary, which it also *resembles in odour.*" (The Italics are mine). "The odour of both drugs is analogous with that of ginger, but weaker unless the rhizome be powdered, when it develops a powerful aromatic odour similar to that of cardamoms." . . .

* Pharm. Journ. [3], x. 830.

† Hist. des Drogues, 6th Ed., ii. 213.

'The round Zedoary is one of the two Zarambáds (Zerumbets), described by Mahometan writers, the other being the *nar-Kachoora* of India, which does not appear to be known in Europe."

"The microscopic structure is essentially the same as that of turmeric, but the resin and essential oil in the cells are of a yellowish-white colour, and the greater portion of the starch grains are ovoid or pyriform instead of narrow and elongated as in turmeric."

According to Bucholz* Zedoary contains volatile oil, a bitter, soft resin, bitter extractive matter, gum, starch, etc. The oil is turbid, yellowish-white, and viscid, has a camphoric taste and smell, and consists of two oils, one lighter, the other heavier than water. Trommsdorff† mentions a substance, which he calls *Zedoarin*, but does not further describe it.

Several authors, amongst whom are Pomet, Dale, Bergius and Woodville, considered that the two sorts of Zedoary were obtained from the roots of the same species of plant and indiscriminately used in the shops, and Guibourt‡ expresses the opinion that the same plant *could* produce both of them; the "round" sort being the large tubers called by Rumphius *matrix radicis*, and the "long" the finger-like processes surrounding it, but in reality they are derived from distinct plants; the numerous species of the genus containing some plants which form long roots, and others developing round ones.

The chemical composition of both round and long Zedoary is said by Pereira§ to be identical.

Flückiger and Hanbury state the chemical composition of Curcuma as follows (Hist. des Drogues, ii. p. 437):—The root contains one per cent. of of volatile oil, which, according to Suida and Daube is principally composed of a liquid corresponding with the formula $C_{10}H_{14}O$, but not identical with Carvol as these last-named investigators assert. The oil also contains a slight proportion of a hydrocarbon. The colouring matter, called *Curcumine*, is obtained by exhausting the drug with benzene after having distilled off the essential oil. The impure crystals obtained by evaporating

* Rep. Pharm., xx. p. 376.

† Watts' Dict. of Chem., v. p. 1060.

‡ Hist. des Drogues, 7th Ed., ii. p. 209.

§ Mat. Med., ii. part i. p. 242.

the benzene, are dissolved in alcohol and precipitated by basic acetate of lead, which is afterwards eliminated by sulphuretted hydrogen and the curcumine re-crystallised from alcohol. It forms into yellow crystals, *having the odour of Vanilla,* and exhibiting by reflected light a beautiful blue colouration. Daube assigned to them the formula $C_{10}H_{10}O_{13}$. According to Gajewsky, Curcumine is best prepared by washing an ethereal extract of Curcuma with a weak solution of ammonia, and dissolving the residue in concentrated boiling ammonia, then, by passing into the solution a current of carbonic acid, the curcumine is percipitated in a flocular form.*

On moistening a piece of paper with an alcoholic solution of curcumine, and bringing the paper in contact with an alkali, a beautiful orange-brown colouration is produced, which changes to violet on drying. Boracic acid communicates to curcumine an orange colouration, changing to blue on the addition of an alkaline solution.†

On the addition of borax to curcumine, a rose-coloured substance is produced, which was named by Schlumberger *Rosacyanine.* Daube obtained this in the crystalline state. Ivanow Gajewsky, who isolated it by warming the alcoholic extract of curcuma with boracic and sulphuric acids, describes it as a crystalline purple powder, giving a green metallic reflection, insoluble in water and soluble in alcohol. Alkalies colour its solution a deep blue. The same chemist also found in the drug a very small proportion of an alkaloid. Kachler found in the aqueous decoction of the root a large quantity of binoxalate of potassium.

* Curcumine also exists in the roots of *Zangiber Cassumunar,* Roxb. (formerly called *Radix Cassumunar*) and in *Curcuma amarissima* Roscoe, *C. alta,* and *C. petiolata,* Roscoe ; all of which plants are figured in Roscoe's magnificent work "Monandrous plants of the order Scitamineæ, 1828."

† This reaction of crude curcumine was discovered by Vogel, as far back as 1815, and has since been utilised as a chemical test for the presence of curcuma as an adulterant in powdered rhubarb and mustard. The following experiment described by Flückiger and Hanbury, demonstrates in a striking manner some of these colour reactions :—Place a little pulverised curcuma on blotting paper and moisten it at frequent intervals with chloroform. A yellow stain is left on the paper, which, by the action of a weakly acidulated solution of borax, exhibits on drying, a purple tint. On then moistening the paper with a weak solution of ammonia the stain assumes a transient blue colouration. In this way the test can be applied in the examination of rhubarb and mustard for the presence of turmeric or curcuma.

Dymock states the market value of the root in Bombay to be 20 to 30 Rs. per kandy of 7 cwt.

The drug known in the Hindi and Bombay dialects as *Nar-Kachoora,* above referred to by Dymock as not appearing to be known in Europe, is stated by him to be the other of the two zurambáds of Arabic and Persian writers on Materia Medica, and although a well-known drug in India, and found in all the shops, is not noticed by recent writers on Indian products. Meer Muhammad Husain states that the plant blossoms from the centre of the leaves like turmeric, which it also resembles in foliage. If this should be the "Tannon-giring *seu* giri" of Rumphius,* it is the *Curcuma viridiflora* of Roxburgh, and described by him in the following terms.† The root consists, like that of the other species, of oblong bulbs, and palmate pendulous tubers, which are inwardly of a deep yellow colour, aromatic and bitter (employed by the Malays of Sumatra to dye with). Leaves, broad-lanceolar, smooth, and from one to three feet long; the petioles and sheaths thereof, about as long. The spike is central and large; the flowers small and very pale yellow. The whole plant, even the spike and coma, are uniformly green.‡ It is a native of Sumatra and other eastern islands. Plants were sent from Bencoolen to the Botanic Garden, Calcutta, where they grow luxuriantly, flowering in July and August.

Dymock describes this drug, as found in the Bombay market, as consisting of small globular, central tubers, from which spring numerous lateral rhizomes about the size of the little finger. It is of a dark grey colour externally and marked with circular rings; internally it is very hard and horny, of a greyish orange when cut in thin slices; odour camphoraceous, taste bitter and camphoraceous. *Examined microscopically,* the minute structure of the rhizome hardly differs from that of zedoary. The starch contained in the parenchyme cells has been altered by heat and appears as a finely granular mass nearly filling the cell. The resin cells are about as numerous as in the zedoary, but the contents are of a dull orange colour. The vascular system consists of scalariform and

* Rumph. Amb., v. 169.

† Flor. Ind. Serampore Ed. i., p. 34.

‡ In *C. montana* the coma of the spike is rose-cloured, and in *C. petiolata* it is lilac-coloured.

spiral vessels, most numerous at the junction of the central and cortical portions of the rhizome.

The drug is said to reach Bombay from Cawnpore. Value, 4 to 5 Rs. per maund of 41 pounds.

Curcuma rubescens Roxb.* This beautiful species is a native of Bengal. Its small, bright yellow, fragrant flowers appear in April and May, soon after the appearance of the leaves, and decay about the beginning of the cool season, in November. Every part of the plant has a strong, but pleasant aromatic scent when bruised, particularly the root. The root consists of several erect, solid, conical, pale straw or pearl coloured powerfully aromatic bulbs, which gave support to the former year's foliage, and are strongly marked with the circular scars thereof; from their opposite sides the scapes and stems of the succeeding year spring, which form similar new bulbs when those of the former year decay; but during their existence, there issues round their lower half, a number of strong fleshy fibres, many of which end in ovate or sub-cylindrical, pale white, slightly aromatic tubers, which also perish with the original parent bulb. The stems are, as in the other species, no other than the united sheaths of the leaves, which like them, decay annually about the month of October and appear again when the flowers begin to perish in April. The leaves are bifarious (six or eight of them forming the above-mentioned stems, of about three or four feet in height, leaves included), petioled on their sheathing base, broad-lanceolate, cuspidate, smooth, strongly marked with parallel veins; of a uniform dark green, with the nerves or ribs red; they are from twelve to twenty-four inches long, by five or six broad; their petioles and sheaths are channelled, smooth, and of a deep red colour; a projecting process in the inside marks, in all this natural order, the limit of the sheath and the beginning of the petiole. The scape is radical, lateral, cylindric, about six inches long, invested in small, dark, reddish sheaths. The spike is tufted, five or six inches long, erect. The coma is less deeply coloured than in Zerumbet. The bractes or scales of the spike are exactly as in the other species, each embracing four or five flowers which expand in succession. The flowers are rather longer than their bractes. The tube of the corolla is slender, its mouth completely shut with three villous, yellow glands.

* Flor. Ind. Serampore Ed. i., p. 28; and As. Res., xi., p. 336.

The propagation and cultivation of most of the species of Curcuma is very simple:—The ground must be rich, friable and in a high situation so as not to be swamped during the rainy season. It may be planted on land occupied the previous year by sugar cane, and is deemed a meliorating crop. The soil, after being well ploughed and cleared of weeds, is raised, in April or May, according as the rain begins to fall, into ridges nine or ten inches high and twenty broad, with intervening trenches nine or ten inches broad. The sets, or small portions of new root, are planted on the tops of the ridges at the distance of two feet apart.

Galangal.

The plant producing the "Chinese Galangal" root, called also the "Lesser Galangal" was identified in 1870 as the *Alpinia officinarum*, Hance. A description of the plant was communicated to the Linnean Society of London, made from specimens collected near Hoihow in the north of Hainan.*

The word *Galanga* appears to be derived from the Arabic *Khulanjan* which, in its turn, was derived from the Chinese Kau-liang Kiang, signifying, according to Porter Smith, Kau-liang ginger; Kau-liang is the ancient name of a district in the province of Kwangtung. The Persian name is Khusrodára.

In the fifteenth century, galangal was evidently in common use; for Saladinus, physician to one of the Princes of Tarentum, *circa* A.D. 1442-1458, reckons it among the things *necessaria et usitata*, which should be found in the shop of every *aromatarius*.†

Very elaborate historical notes on this drug are furnished by Daniel Hanbury in the Pharmaceutical Journal, [3] ii., 248.

The flowering stem is from 2 to 4 feet high, erect, covered by the leaf-sheaths. The leaves are numerous, alternate, distichous, with long, smooth sheaths terminating above in an erect, sub-acute, scarious ligule, an inch or more in length and decurrent at the base along the margin of the sheath; the blade is 9 to 14 inches long, narrowly lanceolate, narrowed at the base but not stalked,

* Journ. Lin. Soc. Botany, 1873, xiii. p. 6; and Bentley and Trimen Med. plants, t. 271.

† "Compendium Aromatariorum," Bonn. 1488, fol.

much attenuated at the apex, entire, very smooth and shining, leathery, bright green. This species has been found wild on the south coast of the island of Hainan. It has also been found near the small village of Tung-sai, a little way from the coast at the southern extremity of the peninsula of Lei-chau-fu, in the extreme south of China and directly opposite Hoi-hau, the port of the island Hainan.

Dr. Hance considers this species very closely allied to *A. calcarata* Roscoe.* He gives, however, several marks of distinction, one of which is the complete absence of yellow in the labellum of *A. officinarum.*

The genus *Alpinia* belongs to the same natural family as the ginger, and is known by its thick, tuber-like rhizomes and by its flowers arranged in terminal spikes. Each flower has an outer row of three pieces and an inner of four pieces, the lowermost of which is three-lobed. The flowers of *A. officinarum* are very elegant, white, the markings and veins being deep red.

The dried rhisomes have evidently been cut into short cylindrical lengths (two or three inches) while fresh. Their thickness rarely exceeds three-quarters of an inch, but is generally less. Many of the pieces are branched, and all are marked at short intervals by whitish, narrow, somewhat elevated rings, which are the scars left by former leaves or scales. The external surface is of a deep reddish-brown; internally they have a paler hue, with a darker centre. The pieces are shrivelled, hard and tough. Examined microscopically, it is seen to consist principally of a uniform parenchyma traversed by fibro-vascular bundles. Some of the parenchyme cells are full of resin and essential oil, but most of them contain large starch granules of an elongated or club-shaped form. Brandes extracted from Galangal, with ether, a neutral, inodorous, tasteless, crystalline body which he termed *Kämpferid*;† this body was examined by Jahns in 1881, and his results published in the Journal of the Berlin Chemical Society. He found that together with this body, galangal rhizome contained two other closely allied bodies, which he named *Galangin* and *Alpinin.* A more exhaustive examination of the root was made by Dr. Thresh in 1884, and the results communicated in a Paper

* Roscoe's Monandrian Plants, t. 68.

† Archiv. Pharm. [ii.] xix. p. 52.

read at the British Pharmaceutical Conference.* The portion soluble in petroleum ether, amounting in total to 2·33 per cent., consisted of 0·6 volatile oil, 0·15 resin and 1·58 of a mixture of fat and *Galangol*, the active, pungent principle. In a previous Paper, "On the Pungent Principles of plants,"† Dr. Thresh named this body *Alpinol*, and classed it in the same group of bodies with *Paradol* and *Gingerol*, all of which are readily soluble in 50 per cent. alcohol. In the details of the valuable researches described in the Papers here referred to, the residue soluble in ordinary ether, amounting to 2·62 per cent., was found to be of an exceedingly complex nature, containing :—

(*a*) Kämpferid, galangin, alpinin and probably other bodies, soluble in dilute solution of sodium carbonate and in alcohol, and precipitated from the latter solution by lead acetate. On decomposing the lead precipitate, &c., these substances are easily obtained in the form of minute sulphur-yellow coloured crystals; they amounted to 1·44 per cent.

(*b*) Other crystalline bodies closely resembling the above, but not precipitated by lead acetate, amounting to 1·18 per cent.

(*c*) A small quantity of a black resinous matter, insoluble in sodium carbonate solution.

The starch amounted to 23·7 per cent., and cellulose to 40·72 per cent.

The odour of *Alpinia officinarum* root resembles the taste of "Grains of Paradise" (seeds of *Amomum Melegueta*). There is a considerable demand for it in Russia for flavouring a liqueur called Nastoika, and by the Tartars it is taken with tea. Irvine says‡ that in India the natives add it to Bazar Spirit to make it more intoxicating.

It is frequently adulterated with the root of *Alpinia Galanga* Swartz, a Javanese plant which furnishes the *Galanga major* ("greater Galangal"); the difference is distinguishable by this latter being larger in size, and of pale chamois colour externally,

* Pharm. Journ. [3] xv. p. 234.

† Ibid. p. 210.

‡ Medical Topography of Ajmeer, p. 171.

contrasting with the brown-orange colour of the interior. *Alpinia Galanga* Swartz yields 0·75 per cent. of essential oil.

Prof. Dragendorff, in his "Studies upon Essential oils,"* states that oil of Galanga is principally adulterated with oil of pimento and oil of cloves, both of which are more soluble in dilute alcohol. A pure sample of oil of Galanga obtained from Herr Zeise, was found to be miscible with 97 per cent. alcohol in all proportions; with 0·2 to 2 volumes of 94 per cent. alcohol it was clear, and with more turbid. With 0·5 volume of 91 per cent., it was clear; with 1 volume, turbid, and not quite clear again with 7·5 volumes. The strength of the spirit used in the various experiments, is according to Tralle's alcoholometer, which gives the percentage volume for the temperature of 60° F.

An adulterated commercial oil was found by the Professor to be clearly miscible with 77 per cent. alcohol in all proportions; with 0·7 volumes of 73 per cent. alcohol, it was clear; but with from 2·5 to 12 volumes of the same, it was turbid. It is therefore probable that the ready solubility of a commercial oil of Galanga can be taken as a sure proof of its adulteration.

Some of the species of *Alpinia* are remarkable for the exceeding beauty of their flowers, such as *A. Malaccensis*, *A. nutans* and *A. mutica*.

Galangal is used as a remedy for indigestion, &c., as a spice, and in the manufacture of beer, vinegar, pickles, gin and liqueurs.

The composition of the volatile oil, according to the researches of Vogel, is represented by the formula $C_{10} H_{16} O$. Its sp. gr. at 15°C. is 0·921. It boils between 170° and 275° C. It contains considerable quantities of cineol (Schimmel).

The *Alpinia sessilis* König† is the *Kæmpferia Galanga* Linn.‡ The roots of this plant are agreeably fragrant and aromatic; the Hindus use them as a perfume, but they do not appear on the London market. It does not produce the Galanga of the druggists and seems to have no other right to its specific name than its supposed identity with that drug by reason of the name given by Van Rheed, "Katsjula Kelengu," in his Hortus Malabaricus, xi. p. 81 t.

* Pharm. Journ. [3] vi., p. 544.

† Retzius, Observ. iii. p. 62.

‡ Sp. Pl. Ed. Willd., i. p. 15, and Roxb. Flor. Ind., i. p. 14.

41. The synonym given by Rumphius is "Soncorus."* The Sanskrit name quoted by Roxburgh for it, is "Chandra-moolika," and the Bengalee "Chundra-moola or Kumula." It is said to be very common in the mountainous districts beyond Chittagong, and is cultivated by the natives, who bring down the roots to the market in Bengal under the name Kumula or Kamala. The roots are biennial, tuberous, with fleshy fibres from the tubers. The leaves are radical, petioled, spreading flat on the surface of the earth, round ovate-cordate, between acute and obtuse, their margins membranous and waved, smooth and of a deep green on the upper surface, somewhat woolly beneath, and streaked lengthways with ten or twelve slender lines. The petioles are hidden in the earth, or rather are only cylindric sheaths embracing those within and the fascicle of flowers. The flowers are in small fascicles of 6 to 12 within the sheaths of the leaves, expanding in succession; pure pellucid white, except a purple spot on the centre of each of the divisions of the inner border or lip. There are three bractes to each flower, a larger exterior one and two within the sides; all are linear, acute, membranous, and half the length of the tube of the corolla. The calyx is the length of the bractes. The tube is long and filiform. The border of the corolla is double and three-parted; the exterior divisions linear and acute; the upper two divisions of the interior are ovate and erect, the under one expanding, two-parted, with lobes bifid. The short filament is two-parted at the apex and re-curved. The anther is replete with white pollen, crowned with a bidentate crest or continuation of the filament above the anther. The stigma is funnel-shaped. König states the nectarial filaments to be two in number, filiform, erect and rather long, embracing the lower part of the style.

Kæmpferia rotunda, Linn,† described by Van Rheed as Malan-Kua,§ and known in Bengalee and Hindee as Bhu-Champa and Bhu-Champaca,‡ is referred to in the 1st series, p. 126. Its biennial, tuberous root was long erroneously supposed to yield Zedoary. It is extensively cultivated in gardens in various parts of India, on account of the beauty and fragrance of its very large

* Amb., v. p. 173, t. 69 f. 2.

† Sp. Pl. Ed. Willd., i. p. 15.

‡ Hort. Mal., xi. p. 17 t. 9.

§ As. Res., iv. p. 242, and xi. p. 328.

flowers, which are of various shades of purple and white, from four to six on each scape. The scapes are just sufficiently long to elevate the flowers from the earth, embraced by a few common sheaths of a greenish-purple colour.

The flowering time is March and April, at which period the plant is totally destitute of leaves, which appear when the flowers begin to decay (as in species of Curcuma), are radical, petioled, oblong, waved, smooth, generally coloured beneath, and, in good soil, about a foot long and four to six inches broad.

For **Galanga alba**, König, see *Amomum medium*, Lour.

Ginger.

This very useful aromatic is furnished by the roots of *Zingiber officinale*, Roscoe (*Amomum Zingiber*, Lin.); (Bentley & Trimen, Med. Plants, t. 270; Pereira, Mat. Med., ii., Pt. i., p. 231).

The genus *Zingiber* consists of herbaceous Indian plants, with creeping, jointed, woody rootstocks, from which are sent up every year stems surrounded by sheathing leaves arranged in two ranks. The flowers are borne in cone-shaped spikes, thrown up from the rootstock and protected by bractes.

Z. Officinale is a native of tropical Asia, and is largely cultivated both in the East and West Indies; also in Africa (Sierra Leone), Siam (a so-called ginger) and in Queensland, in Australia.

The quality and commercial value of the dried rhizome differs considerably in different localities, and is influenced very much by the method of cultivation, collection and preparation.

The method of cultivation in Jamaica has been described* as follows:—"The most suitable soil for ginger culture is a well-drained clayey loam. The land should be well dug and cleared of weeds. Small pieces or protuberances of the root, one or two inches long, are planted during March or April, four inches deep and nine to twelve inches apart. It is well to cover the land with a moulding of dead leaves, straw, or litter mixed with manure. In a few months the whole ground will be covered. The flowers appear in September. When the stalks wither in the following

* Bulletin of the Botanical Department of Jamaica, December, 1891.

January or February, it is time to dig up the roots. When the tubers have arrived at maturity, and have put forth stems, they are fibrous, but before this takes place they are still succulent, and if required for preserving should then be taken up. Ginger is an exhausting crop on the soil, and should not be planted on the same ground two consecutive years. The yield per acre is said to be 4,000 pounds and upwards."*

The dried ginger received from Jamaica is prepared when the stalks are wholly withered, the rhizomes then being about a year old. This happens in January or February. The rhizomes are dug up and separately picked, washed and scraped : they are then dried in the sun and open air. The product is the "uncoated ginger" of the shops, formerly called "white ginger" (*zingiber album).* The "coated ginger" of the shops has obviously not undergone this careful preparation.

The following account of the cultivation of ginger in India, as carried on in the Hill States adjoining the Ambàlah district, was supplied to the compilers of the Official Catalogue of the Indian Department of the Vienna Universal Exhibition :—"Ginger is principally produced in Mahúr Mássá, Patrá, Dárrá, Kothi, Kotahi, Bágal and Jayál. The best pieces of last year's harvest are selected and placed in the corner of a house in the month of Phagan ; the heap is then smeared over and covered with cow-dung to keep the roots from drying up in Hár month, when the first rain falls. The land is ploughed up two or three times, and then divided off into beds, with a little raised edge round each bed, care being taken to make openings to let superfluous water run off ; for if water stands on the crop the roots will rot. Little pieces of the roots are then buried three inches deep in the soil at intervals of nine inches, and the field is next covered over with the leaves of trees, which keep the soil moist, and over the leaves manure is spread to a depth of half an inch ; when it rains, the water, impregnated with manure, filters readily through the leaves to the roots. Artificial irrigation is not employed while the rainy season lasts, but from Assúh to Poh it is necessary. In the month of Poh the plants are about two feet high. In the months

* The production of ginger in Jamaica seems to be decreasing ; probably in consequence of the exhausting nature of the crop unless a proper system of cultivation be adopted. In 1887 a ginger worth 16s. per cwt. was worth 49s. 6d. per cwt. in July, 1893.

of Sawán, Bhadon and Assúh the field is weeded three times." The writer of the above Report adds that "In the month of Poh, the plants being about two feet high, have eight tubers to each shoot; these are dug out and buried in another place for a month, and are then taken out, exposed to the sun for a day, and are then fit for use." It is presumed that he means they are fit for use as "green ginger," for he says, in continuation of the Report:—"In order to dry ginger into 'south,' the fresh roots are put into a basket, which is suspended by a rope, and then two men, one on each side, pull it to and fro between them by a rope attached, and thus shake the roots in the basket; this process is carried on for two hours every day for three days. After this the roots are dried in the sun for eight days, and again shaken in the basket. The object of the shaking together is to take off the outer scales and skin of the roots. A two days' further drying completes the process."

Writing on the "Commercial Drugs of the Chinese province of Kwang-tung," Dr. Hirth du Frenes of Amoy, China, says:—"Ginger grows in nearly all parts of the province of Kwang-tung. The district of Nan'-hai, which belongs to the city of Canton, produces greater quantities and a better quality than the other neighbouring districts. The independent tribe of the Miso-tsu, in the mountains at the north-western border of the same province, are also said to produce large quantities of ginger. In the district of Hsin-hsing, about 30 miles south of the city of Chao-ching, on the Western River, three-tenths of the flat land and seven-tenths of the cultivated soil in the hills are planted with ginger. A distinction is made between flat land ginger (in the Canton dialect *Ten-Keung*), which is generally soft and tender, and mountain ginger (*Shan-Keung*), which is brittle and very pungent. For home consumption the Chinese pickle it in vinegar; the more expensive syrup-ginger (*t'ong Keung*) is almost exclusively consumed by foreigners or exported."*

In a paper by Weynton on "The Commercial Products of Siam," read before the East Indian Association in April, 1887, the following information was given respecting "Siamese ginger":—"If well cultivated, highly manured and treated with care, it can be grown at considerable profit. It is reared in a desultory

* New Remedies, June, 1877.

manner in almost every village, but so little care is bestowed upon the culture and drying that the minimum price is obtained in the local bazaars. Generally speaking, the roots when taken up receive but a superficial washing, are then smeared with fresh cow-dung and hung in baskets or spread in trays among the rafters of the native huts, the ever-ascending smoke doing the rest. The result is that the turn-out presents a most uninviting aspect, dirty, shrivelled, and, despite the almost constant smoke, the dried tubers are almost invariably riddled with the bamboo-borer insect. If on being dug out, the tubers are thoroughly well scrubbed in water with a hard brush until every earthy particle is removed, and then steeped for a night in a solution of lime water (one ounce of unslaked lime to the gallon), and then well rinsed in clean water and dried slowly in a brick oven at a temperature of 140° to 160° F., it will command a price closely approximating the best Jamaica ginger; this was ascertained some years ago in the case of some samples so treated on one of the Sylhet plantations. Though ginger may be had as stock from almost any village, the best is procurable from the bazaars frequented by the hill tribes under the foot of the hills."

The marked difference between the Chinese preserved ginger and that from the West Indies has been the subject of enquiry by the authorities at Kew, as to whether both articles are really the product of the true ginger plant (*Zingiber officinale*). An interesting account of the investigation is given in the "Kew Bulletin" for January, 1891, p. 5. Mr. Watson of Kew, appears to have been the first to suggest that the Chinese ginger plant is probably a species of *Alpinia*, and possibly identical with the Siam ginger plant which was described by Sir J. Hooker in the Botanical Magazine (t. 6,946), in 1887. Mr. J. G. Baker, in working up the *Scitamineæ* for the "Flora of British India," arrived at the conclusion that it is not distinct from the *Alpinia Galanga*, Willd.

As regards the so-called "Siam Ginger," Mr. Watson of Kew, writing to the 'Gardeners' Chronicle,' July 31, 1886, says:—"Amongst the collection of fruits, etc., shown by the Siam commission at the International Health Exhibition, held at South Kensington in 1884, were some roots labelled 'Ginger.' These were obtained for the Kew Museum, bnt one of them being alive was planted to grow, and it is now bearing stems five feet high,

and is in flower. On comparing it with the drawings and specimens in the Herbarium, Mr. Baker has identified it with a specimen labelled "Alpinia sp., Bangkok," which was collected by Sir R. Schomburgk in 1864, and which is very near to *Alpinia allughas*, also a native of Siam, where, according to Schomburgk, it is cultivated for its cardamomum-like fruits, and is known as *Luk-Reu*, or bastard cardamom. Under the name of Galangal, *A. officinarum*, a Chinese species, is cultivated for the sake of its aromatic rhizomes, and this unnamed species now in flower at Kew, is apparently largely cultivated by the Siamese as a substitute for ginger. The rhizome is very thick, slightly flattened and not so freely branched as in common ginger; it has the pungent aromatic properties of ginger, so far at least as could be told by tasting it."

Thus, the weight of evidence is in favour of the conclusion that the Siamese and Chinese gingers are identical, and that both are the produce of *Alpinia Galanga*, Willd. Yet, considering the wide distribution of *Zingiber officinale*, it is still possible that the true ginger may also be cultivated in some parts of China. In the true plant the inflorescence is borne on a separate short stem without any leaves, the barren stems being about three feet high, and clothed with narrow spear-shaped foliage; in *Alpinia* the flowers are borne in panicles on the ends of the stout leaf-stems.

Dried ginger is called by the dealers "races" or "hands." It is in flattish, jointed, branched, or lobed, palmate pieces, which rarely exceed four inches in length. The Barbadoes, Bengal and African gingers are covered by a dry, shrivelled epidermis commonly called the "coat"; hence these sorts are usually said to be *coated* or *unscraped*; whereas the Jamaica ginger and some of the sorts brought from Malabar and Bengal, have been deprived of their epidermis, and are therefore called *uncoated* or *scraped*. The external colour varies in different sorts from pale or bright yellow to dark or brown: the palest sort is the fine Jamaica ginger, and this realises the highest price. Cochin ginger resembles it, but is of a pale brownish tint externally. The Calicut variety of Bengal ginger is harder and darker than the Cochin. The Barbadoes, Bengal and African are coated gingers.

Ginger breaks moderately short, but the fractured surface presents numerous projecting pointed fibres imbedded in a mealy

or farinaceous tissue. A transverse section of the larger and more perfect pieces shows an outer horny, resinous-looking zone, surrounding a farinaceous centre, which has a speckled appearance from the cut extremities of the fibres and ducts. The interior varies like the exterior in colour: the best ginger is that which cuts pale but bright. The consistence of ginger, as ascertained by cutting, varies from soft to hard, or, as it is termed in trade, "flinty," the soft being preferred.

Ginger is sometimes washed in water, and then dried, prior to its being offered for sale to the retailers.

According to several text-books, the chalky-white appearance of the so-called "bleached ginger" is said to be produced by submitting the root to the action of the fumes of burning sulphur or by washing it in a solution of chloride of lime, but it is far more likely that this appearance results from a simple application of common whitewash and dusting it over whilst wet with plaster of Paris. Investigations in this respect were made by Garside in 1874:*

Five samples were obtained from different shops. On two of these the easily detached white powder was found to consist of calcium sulphate, in one case with a trace of chloride, and in the other without any. The presence of calcium disposed of the supposition that sulphurous acid only was used in the bleaching process. If, however, the ginger had been first steeped in solution of chloride of lime and afterwards exposed to sulphurous acid fumes, calcium sulphite would in all probability be formed, which, on exposure to the air would become converted into sulphate. The absence of any notable amount of chloride would preclude this idea. The powder on the remaining three samples was found to consist principally of calcium carbonate, with smaller proportions of sulphate and chloride. In order to ascertain the amount, an average piece of ginger was taken and the adhering mineral matter separated and weighed. It amounted to 2·33 per cent. of the ginger employed, and consisted of—

Calcium chloride	4·98
„ sulphate, with other salts	7·90
„ carbonate	87·12
	100·00

* Phar. Journ. [3], iv., p. 831.

The small proportion of chloride here shown would justify the assumption that the chloride of lime process had not been employed. Moreover, on two out of three samples containing calcium carbonate, small particles of ultramarine blue were detected; and this, under the name of "lime-blue," is commonly used to improve the colour of lime washes. From these facts it would appear that three of the samples had been simply white-washed, without any attempt at bleaching, and then dusted over with plaster of Paris.

Powdered ginger is adulterated with sago-meal, potato-flour, wheat-flour, ground-rice, cayenne pepper, mustard husks, and turmeric powder and various amylaceous substances blended in varying proportions. These adulterations are readily detected by the microscope, except in the case of the East Indian arrow-root (*curcuma angustifolia*) the particles of which are similar in appearance to those of ginger.

A very elaborate study of the constituents of ginger was made by Thresh, and formed the subject of a paper read at the British Pharmaceutical Conference in 1879.*

A partial investigation of oil of ginger was made by the same scientist, and was also read as a paper at the Conference of 1881.† In this last paper it is stated that the proportion of essential oil obtained from a sample of Jamaica ginger amounted to 1·4 per cent. The yield of oil from various gingers has been noticed by other observers‡ to be from 1·9 to 2·7 per cent., having a sp. gr. at 15° C. of 0·880 to 0·885, and an optical rotation of—25° to—40° in a 100 m. m. tube. The chemical composition of ginger oil remains unknown, but the presence in it of camphene and phellandrene have been detected.§ The complex nature of the oil is indicated by the wide range of its boiling point; the results obtained by Thresh, on fractionating, are recorded as follows:— "When distilled after drying over $Ca\,Cl_2$ the oil begins to pass over at about 140° C., accompanied by a few drops of aqueous fluid. The temperature constantly and rapidly rises to about 240°, the chief portion of the oil coming over between 240° and

* Reprinted in Pharm. Journ. [3], x. pp. 171 and 191.

† Reprinted in Pharm. Journ. [3], xii. p. 243.

‡ Schimmel's Report, October, 1893.

§ Ibid, p. 25.

270° C. A little passes over between 270° and 300°, but evidently accompanied by decomposition products, and a transparent brown tenacious semi-solid residue remains in the flask.

The English oil gave :—

Boiling below* ...	150° C.	about	5	per cent.
„ between ...	150°-200° C.	„	10	„ „
„ „ ...	200°-240° C.	„	8	„ „
„ „ ...	240°-265° C.	„	60	„ „
„ „ ...	265°-300° C.	„	7	„ „
Residue in retort ...		„	10	„ „
			100	

From the "Foreign" oil was obtained :—

Boiling below	210° C.	about	17	per cent.
„ between ...	210°-250° C.	„	15	„ „
„ „ ...	250°-270° C.	„	45	„ „
„ „ ...	270°-310° C.	„	10	„ „
Residue in retort ...	... ...	...	13	„ „
			100	

The lower boiling products retained the ginger aroma (perceptible when diluted with spirit) and were much more soluble in rectified spirit than the higher fractions." Further than this, Thresh's researches do not appear to have led to any definite conclusion as to the constitution of the oil.

Oil of ginger is yellow in colour. Its odour is intensely that of the root (the oil of Jamaica root being the most fragrant), but it has not the pungent burning taste of ginger; this taste is due to *gingerol*, the active pungent principal of the root. Probably it is for this reason that the spirituous extract of the rhizome is preferred by the liqueur makers, as it contains both the essential oil and the pungent principle.

Gingerol. The investigations of Thresh show that this body exists in the dried rhizomes to the extent of from 0·600 to 1·450 per cent. He eliminated it in the form of a viscid fluid of about the consistency of treacle, of a pale straw colour, entirely devoid of odour, and of an extremely pungent and slightly bitter taste. It

* All boiling points are corrected for portion of thermometer tube not immersed in vapour.

is very soluble in alcohol (even when diluted to 50 per cent.), benzene, volatile oils, carbon disulphide, solutions of potash and ammonia, and glacial acetic acid. It is very slightly soluble in petroleum ether. The alcoholic solution is neutral in reaction and gives no precipitate with the acetates of lead nor with lime. It does not yield glucose when treated with dilute sulphuric acid; strong sulphuric acid dissolves it with production of a brown colour; hydrochloric acid does not affect it; nitric acid converts it into a blood-red resinous substance. The sp. gr. of a slightly impure specimen was 1·09 at 15° C.

The other constituents of ginger were found by Thresh to be odourless and tasteless resins, starch, mucilage, metarabin, pararabin, organic acids, oxalic acid (as $Ca\ C_2\ C_4$), cellulose, albuminoids, vasculose, indifferent substances precipitated by tannin, a substance precipitated by acids, fat (? wax), and from 11 to 14 per cent. of moisture.

"**Black ginger**" of commerce is prepared by washing the root in water, boiling for a quarter of an hour, and then drying in the sun. Formerly it was in much greater demand than at present.

Green ginger is sometimes imported from Jamaica. It consists of soft succulent rhizomes and appears to have undergone but little preparation beyond picking and washing.

Preserved ginger (*Conditum Zingiberis*) is the delicious preparation received in jars from Jamaica and China, the former being the finest. It is made from the young tubers which are put forth every spring by the perennial rhizome, these are carefully picked, scalded, washed in cold water, and then peeled. The roots are then covered with a weak syrup, and left for two days. The syrup is then poured off and replaced by a stronger syrup, and this is repeated two or three times until the syrup is thick and the ginger bright and nearly transparent.

The following is given as a superior method of preparing preserved ginger:—"Pour boiling water on the ginger, and let it steep for a day and night, then peel and pare away all discoloured and hard parts. Boil a syrup of 1 pound of lump sugar to 6 pints of water (this is for 12 pounds of ginger). Put the ginger into a stone jar and pour the thin boiling syrup on it, let this stand for a

week or ten days, then draw off the syrup and throw another, exactly the same quantity as the last, again boiling, over the ginger; let this stand for another week, then throw off the second syrup and drain the ginger well on a hair sieve, return it to the jar, and pour over it the final syrup made as follows :—12 pounds of loaf sugar to 12 pints of boiling water; stir till the sugar is dissolved for fear it should settle and burn, then boil till it is as thick as good honey and drops slowly from a silver spoon; now pour boiling water over the ginger and let it stand till cold, when it can be put into the bottles or jars in which it is to remain. Put in the pieces of ginger first, as close as they will pack, then fill right up to the cork, to leave no room for air. The corks should be new and good, not old ones that have been pierced by corkscrews.*

Candied ginger is also imported, in boxes.

Soluble essence of ginger. The following is the method of preparation recommended by Thresh :—" Take a strong tincture (1 to 1) of finest Jamaica ginger one pint, add in small portions at a time finely-powdered slacked lime, shaking vigorously after each addition, until the tincture ceases to lose colour, throw the whole upon a filter, and pass through the residue proof spirit until the product measures two pints. Now add, drop by drop, dilute sulphuric acid until the rich yellow of the tincture suddenly disappears, let stand for twenty-four hours, dilute with water to four pints, shake with a little powdered pumice or silica (by no means lime or magnesia), and filter at 0° C. if possible. The *rationale* of the process is as follows :—

As may be gathered from a consideration of the constituents of ginger root, the alcoholic tincture will contain besides the extractive, soluble in water, which need not further be considered, essential oil, neutral resins (α and β), gingerol, and small quantities of the red fat (? wax) and peculiar extractive, insoluble in ether. Upon agitating the tincture with lime, the greater part of the α and β resins is removed, and by addition of the acid the lime which has entered into solution is precipitated. The addition of water precipitates the neutral resin, wax, fat and peculiar extractive, and unless the ginger from which the original tincture was prepared was poor in oil, the excess of volatile oil

* Journal of the Society of Arts, 13th May, 1892.

also. As in probably all cases the soluble essence is saturated with essential oil, the final filtration must be effected at a lower temperature than any to which the essence is likely to be exposed. The product as thus obtained is very pale in colour, but if a darker essence is preferred it is only necessary to add one or two drops of solution of potash to give an alkaline reaction, when the rich orange tint due to the action of the alkali upon the remainder of the β resin will be immediately produced." The elegant preparation has been found very useful for the manufacture of aërated water.

Grains of Paradise.

These seeds, above-mentioned as having an aromatic, pungent taste, reminding of the odour of Galangal, are the produce of *Amomum Melegueta*, Roscoe, an herbaceous perennial plant of the same Natural Order as Ginger, three to five feet in height, native of Guinea, and widely distributed in western tropical Africa, being found near the coast from Sierra Leone to the Congo. The part of the coast known as the "Grain Coast," or "Pepper Coast," by reason of its production of "Grains of Paradise," is situated between Liberia and Cape Palmas. The Gold Coast, where these seeds are chiefly forwarded to, is more eastward, in the Gulf of Guinea. The plant is grown in other tropical countries, and has succeeded in Guiana (Demerara).

The word "Meleguetta," which is sometimes spelt in other ways, is the African name of the seeds, although Humboldt accounts for the word as a derivation from the Indian word *Malaga*, meaning Pepper,* in fact; these seeds also bear the English name "Melegueta Pepper," besides that of "Guinea grains." The name Melegueta Pepper is not exclusively applied to these seeds, but is used to designate the fruit or seeds of several Zingiberaceous plants,† as well as to Pimento and Allspice.‡

The plant is totally distinct from the *Amomum Granum Paradisi* of Linnæus, Hooker,§ Afzelius‖ and Smith.¶ The *Amomum*

* Examen critique de l' Hist. de la géographie, i. p. 257.

† Pharm. Journ. [i.] ii. p. 443.

‡ Ortega, Histo. nat. de la Malagueta, ó Pimenta de Tavasco.

§ Hooker's Journ. of Bot. and Kew Misc., vi. p. 295.

‖ Remedia Guineensia Upsaliæ, p. 71.

¶ Rees' Cy. Art. Mellegetta and Sup. Art. Amomum.

described by Smith as *A. grana Paradisi* is identical with *A. exscapum* of Sims, and the same wood block used to illustrate Smith's plant was used by Pereira* to illustrate Hooker's plant. Its seeds are highly aromatic, but do not possess the pungency of the real grains of Paradise.

A figure of *A. Melegueta,* published by Roscoe in his "Monandrian Plants of the order Scitamineæ," was drawn from a plant raised and flowered in the Botanical Garden, Liverpool, from a seed of Melegueta Pepper or Grains of Paradise of the shops. The identity of the true plant with Roscoe's representation of it has since been confirmed by Daniel Hanbury, who states† having frequently germinated the seeds of the Grains of Paradise of commerce, and not only flowered the plants so obtained, but even matured the seeds, thus deciding a question so long discussed by botanists. A figure of *A. Melegueta* Roscoe is given by Pereira, in his Mat. Med. ii., pt. 1, p. 245, and a more recent illustration is to be found in Bentley and Trimen's Med. Plants, t. 268.

The plant has a long, slender, twisted, branched, horizontal rhizome, surrounded with numerous large, loose, persistent, blunt, sheathing bractes. The leaf-bearing barren stems are from three to five and even six feet high, erect, straight, slender and completely enclosed in the very long leaf-sheaths. The leaves are very large, alternate, distichous, sheathing, the sheaths split throughout, very long, close, striate, quite smooth, rounded at the top, and terminating in a short rounded ligule ; the blade (wanting in the lower leaves) six to nine inches long, lanceolate oblong, attenuated at the apex, narrow at the base, entire, convolute in vernation, midrib narrow and prominent, lateral veins very fine. The scape is radical, rising but very slightly above the surface of the soil and covered at the base with five or seven imbricated, ovate, concave, pointed and somewhat cuspidate bractes. The calyx is cylindrical, of one leaf, green, spotted with red. The very large cylindrical flowers are waxy in appearance, delicately beautiful and expanding in a double border, the outer one in three sections, the middle or largest of which is ovate, the other two linear and opposite. The fruit is a cylindrical, coriaceous capsule, yellow, spotted with orange, or sometimes red, supported at the base by imbricated

* Mat. Med., ii. pt. i. p. 244.

† Hist. des Drogues ii., 459, foot note.

bractes. The size of the different parts of the plant varies considerable according to the more or less favourable conditions of soil and climate in which it grows. In Demerara, where the plant succeeds very well under cultivation, the fruit attains the size of a fine pear, whilst in some parts of Western Africa its dimensions scarcely exceed those of a large almond; a stunted appearance which at one time led to the belief of its being a distinct variety. The pericarp is thick and fleshy, enclosing a colourless acid pulp of agreable taste, in which are lodged the numerous shining, hard, wrinkled, brownish-red seeds, which are rather variable in form, being roundish or ovate and frequently bluntly angular. They are used by the natives as a condiment, and in Europe for giving an artificial sensation of strength to spirits, wine, beer and vinegar and a piquant flavour to cordials and liqueurs.

The distilled oil of the seeds was known and used medicinally in the commencement of the seventeenth century* ; the yield is very small, only about 0·30 per cent. It is a neutral yellow oil, of agreeable odour similar to that of the seeds and of the same aromatic taste, but without the bitterness. Its composition and physical properties have been recorded as follows† :—Its sp. gr. at 15·5°C. is 0·825. It is but slightly soluble in alcohol, either absolute or diluted, but forming with carbon disulphide a clear liquid and dissolving iodine without explosion. On saturating it with dry hydrochloric acid gas, no solid compound is formed. It commences to boil at about 236°C. and the greatest part distils between 257° and 258°C., leaving a thick brown residue. Examined in a 50-millimetre tube, the crude oil deviates the polarised ray 1°·9 to the left. The portion distilling above 257°-258° deviates it 1°·2 and the residue 2° to the left. These optical properties lead to the conclusion that it is an homogenous body,—an opinion which was corroborated by the results of three elementary analyses which resulted in the formula $C_{20}H_{32}O$ or $C_{10}H_{16}+C_{10}H_{16}O$ (F. and H. in the work cited, who further observe):—With a view of ascertaining whether the seeds contained any fixed oil, ten grams were pulverised with quartz and exhausted with boiling ether. On evaporating the ether, 0·583 gram of brown viscous residue was obtained, which was almost odourless,

* Porta, "De Distillatione, Romæ, 1608, lib. iv. c. 4.

† F. and H. Hist. des Drogues, ii. p. 459.

but of very strong, pungent taste. As this was entirely soluble in crystallisable acetic acid and in dilute alcohol, it may be concluded that it was a resin, and that grains of Paradise do not contain any fixed oil.

The pungent principle contained in Grains of Paradise has been isolated and examined by Dr. Thresh and named *Paradol.* Its description was given in a very interesting paper on "The Pungent Principles of Plants" read at the 21st Meeting of the Pharmaceutical Conference.* What is meant by "Pungent principles" is a class of bodies destitute of odour, possessing a purely burning taste, and neither bitter, nauseous, nor acrid. The best known drugs containing such principles are cayenne pods, the rhizomes of ginger and galangal, the peppers, and Grains of Paradise. These principles are readily soluble in 50 per cent. alcohol.

Grains of Paradise are sometimes met with in the shops of European druggists under the name of *Semina Cardamomi majoris,* a name mentioned in the very early European works on pharmacy, notably in the "*Thesaurus Aromatariorum,* printed at Milan in 1496; it is there called *Gardamomum majus,* also *Heil,* the name under which the ancient Arabian physicians described the *Amomum Kororima* or *Cardamomum majus* of Matthiolus.

Angostura.

True Angostura is the bark of *Galipea Cusparia,* A. Saint-Hilaire (ex De Cand. Prodr. i. p. 731). Syn. *Cusparia febrifuga,* Humboldt; *Galipea officinalis,* Hancock; *Bonplandia trifoliata,* Willdenow: *Angostura trifoliata,* Ræmer et Schultes; *Galipea febrifuga,* Baillon. Figured in Bentley and Trimen, Med. Plants, t. 43.

The tree yielding this bark is found in abundance on the mountains of San Joaquim de Caroni in Venezuela between the 7th and 8th degrees of latitude, and is especially common in the country about the gulf of Santa Fe. It was found by Hancock in the districts of Tumeremo, Uri, Alta Gracia and Gupapui, which are situated on the east of Caroni river, and near to its junction with the Oronoco. The name "Angostura" appears to have been originally applied to

* Pharm. Journ., [3] xv. p. 208.

it after a district of that name where it was first found. This tree, of the Natural Order *Rutaceæ*, is described by Flückiger and Hanbury as being only 4 or 5 metres in height, with a trunk of 7 to 10 centimetres in diameter; other writers state the height to be from 50 to 80 feet, with a straight trunk crowned with a tuft of foliage, so presenting the appearance of a palm tree when viewed from a distance. The leaves are bright green, very odoriferous, and full of glandular dots.* They are alternate, evergreen, on stalks of about a foot in length, and composed of three sessile, oval-lanceolate, sharp-pointed, entire, smooth folioles of about the same length as the stalk, but differing in length with each other. The flowers are in axillary and terminal bunches; white, or slightly tinted with pink, of about two centimetres in length, having a thick calyx formed of five white, short, unequal sepals. Corolla five-petaled. Stamens five to seven, bnt generally only two are fertile. The fruit is formed of five capsules enveloped by the persistent calyx.

Complete details of the microscopic structure of the bark, also of the "False Angostura bark," and tests for distinguishing between the two are given by the translators of the Pharmacographia.† Under a lens the transverse fracture of the true bark shows a number of white points or minute lines, which are not present in the false bark (that of *Strychnos Nux Vomica.*)‡

As met with in commerce, true Angostura bark is in slightly quilled or in flattish pieces of 15 centimetres in length at most, but generally shorter. The flat pieces are 2½ centimetres or rather more in width, and ¼ of a centimetre thick. The edges are *sharp* and *bevelled* in a very characteristic manner, and the internal surface is easily capable of being split into laminæ. The outer surface consists of a yellowish grey layer, generally sufficiently soft to be easily removed by the nail, exposing the blackish-brown resinous under-surface. The inner side is light brown, its rough and exfoliated surface being indicative of its tenacious adhesion to

* It is probable that an essential oil eould be distilled from these leaves.

† Flüekiger and Hanbury, Hist. des Drogues, i. p. 204.

‡ See Pharm. Journ., 1836, p. 662, also Pharm. Journ. [3], iii. p. 663, and [3] iv. p. 681. For figure of the trne bark see F. and H. Hist. des Drogues, above referred to, also Goebel nnd Kunze, Pt. i., taf. ii., figs. 1-4. Details as to the means of distinguishing, ehemically and otherwise, between the two barks, are also given by Pereira, in Mat. Med. [ii.], part ii., p. 1915.

the wood, fragments of which are frequently found upon it. A drop of nitric acid colours this inner side of the bark a very *dull* red. The bark of *Strychnos Nux Vomica*, containing Brucia is turned a *bright blood-red* on the addition of a drop of nitric acid. The fracture of the true bark is short and resinous, showing white, angular points which are deposits of calcium oxalate.

The peculiar odour of Angostura bark is due to an essential oil, discovered by Herzog,* who obtained it in the proportion of ¾ per cent. The absolute content of essential oil in the bark has since been found by Messrs. Schimmel & Co., to be 1·5 per cent. The oil is yellow, rapidly assumes a dark tint when exposed to the air, has an aromatic odour and taste, possesses the sp. gr. of 0·936 at 15° C., is soluble in ether, alcohol, petroleum ether, chloroform, and glacial acetic acid. It has an acid reaction. It begins to boil at 153° C., the greater portion passing over between 200° and 220°, and on redistillation to a great extent at 203° C. (Bekurts and Wehring).

The bitter principle contained in the bark was discovered by Saladin in 1833, and termed *Cusparine;* this is a neutral crystalline body, melting at 45° C., soluble in alcohol and in acids, but sparingly so in water, and obtainable by spontaneous evaporation or distillation *in vacuo* of the tincture. It is also precipitable by tannic acid. The amount of this substance furnished by the bark, is ⅕ per cent., according to Flückiger and Hanbury, but some observers have put it higher.†

Angostura bark also contains a hard and a soft resin, the latter coloured dark red by nitric acid. A cold aqueous solution of the bark treated with ferric chloride, gives a copious reddish-brown precipitate. Thin slices of the bark are not coloured by a solution of ferric sulphate, consequently tannin does not appear to be present.

Medicinally, the bark is stimulant and tonic. In hot climates it has been employed with success in fevers of a malignant type; the dose being from 10 to 40 grains of the powdered bark. It is also used in cases of dyspepsia, dysentery, and chronic diarrhœa, but in Europe it has fallen out of use, probably by reason of the risk of its being adulterated with the poisonous "False bark."

* Archiv. der Pharm., 1858, xciii. p. 146.

† Dr. Muter, in his "Organic Materia Medica," states the amount of this substance to be 1½ per cent.

Still, it is largely used in the manufacture of the aromatic bitter known as "Angostura Bitters." This, taken in moderation, mixed with a little sherry wine, acts as a tonic and stimulant to the organs of digestion. It increases the appetite for food, removes flatulence and acidity arising from dyspepsia, and possesses the singular advantage of not oppressing the stomach as Peruvian bark is apt to do.

The name "*Galipea*" was framed by Aublet from the vernacular appellation in French Guiana of *G. trifoliata*, where that species is indigenous,* being found on the banks of the river Orapu. By the inhabitants of Guiana it is also called "Inga." Its leaves are trifoliate and smooth; flowers, corymbose; peduncles shorter than the leaves; flowers, greenish; stamens, four, of which two are sterile. This species is a shrub of six feet in height.

Other species with compound leaves are :—

G. Ossana (D. C. in Mém. Mus. d'Hist. Nat., ix. p. 149, t. 10). A shrub of 6 feet in height, native of Cuba, about the Havannah. Leaves trifoliate, smooth; flowers panicled, peduncles longer than the leaves; flowers small, greenish; calyx 5-parted, sterile stamens 5, fertile 2.

G. lasiostemon, St. Hil. Syn. *Lasiostemum sylvestre*, Nees et Mart. in Nov. Act., xi. p. 171, t. 19. This shrub is a native of Brazil, in woods at Ilheos. The leaves are trifoliate, full of glandular dots; the young ones, petioles and branchlets pubescent; racemes almost terminal, erect, pubescent; petals villous on the inside and pubescent on the outside, as well as the calyx; stamens fringed, villous, 3 fertile and 2 sterile.

G. aromatica, Spreng. Syst. app., p. 91. Syn. *Raputia aromatica*, Aubl. Guian., ii. p. 670, t. 272. *Sciuris aromatica*, Vahl. in Willd. Spec., i., p. 153. This shrub is a native of Guiana, and found in the woods of Orapu. It is about three feet in height, with smooth trifoliate leaves. The racemes are spicate and axillary. Flowers greenish; 3 sterile stamens and 2 fertile. The bark of the trunk is aromatic.

* Aublet, His. des Plantes de la Guiane Française, ii. p. 662, t. 269; See also De Jussieu, in Mémoires du Museum d'Hist. Nat., xii. p. 493, t. 23, No. 34 and D.C. in the same, ix. p. 642 and 148.

G. heterophylla, St. Hillaire.* This shrub is a native of Brazil, in the province of Rio Janeiro. Its leaves are 3, 4 and 5 foliate, on long petioles; leaflets lanceolate, rather pubescent on the middle nerve; racemes super-axillary, on long peduncles; sterile stamens 2.

A plant is described and figured in the Botanical Register, xvii., t. 1420, as *Galipea odoratissima*; the leaves are simple, obovate, obtuse and on short stalks. The writer in the Botanical Register states that a specimen of this most fragrant plant was received by the Horticultural Society from Rio Janeiro, and, as grown in constant stove heat in England, it attains the height of about two feet and is covered nearly to the bottom with its broad, deep green leaves. When in flower, the whole atmosphere of the hothouse is perfumed as if with jasmine, and the period of blossoming lasts some time.

Cardamom.

Of the seeds of the different sorts of cardamoms, the most esteemed are those contained in the dried capsules of *Elettaria Cardamomum* Maton† (*Alpinia cardamomum*, Roxb.). This is the *Elettari* of Rheede.‡

Elettaria is a genus of *Zingiberaceæ*, consisting of large perennial herbs, having much the appearance of *Amomum*, but distinguished from that genus by the elongated filiform tube of the corolla, by the presence of internal lateral lobes in the shape of very small tooth-like processes, and by the filaments not being prolonged beyond the anther. All the species are natives of the tropical parts of India.

The specific botanical characters of *E. Cardamomum*, which furnishes the fruits known as Officinal Cardamoms, commercially known as " small " or " Malabar " cardamoms, are as follows:—

Rhizomes thick, fleshy or woody, and ringed with the scars of the attachment of previous leaves, giving off fibrous roots below. Stems perennial, erect, smooth, jointed, enveloped in the spongy sheaths of the leaves; from 6 to 9 feet high. Leaves large,

* Bulletin des Sciences par la Société Philomatique de Paris, 1823, p. 131; also St. Hillaire, Pl. rem. Brés, p. 131, t. 12.

† Trans. Lin. Soc., x. p. 254.

‡ Hort. Mal., xi. t. 4, 5 and 6.

alternate, sub-sessile in their sheaths, entire, lanceolate, fine pointed, pubescent above, silky beneath, length from 1 to 2 feet. Sheaths slightly villous with a roundish ligula rising from the mouth. Scapes several (3 or 4) from the base of the stems, resting on the ground, flexuose, jointed, branched, from 1 to 2 feet long. Branches and racemes alternate, one from each joint of the scape, sub-erect, two or three inches long. Bractes solitary, oblong, smooth, membranous, striated, sheathing, one at each joint of the scape, embracing the insertion of the raceme or branch, and one at each of their joints. Flowers alternate, short-stalked, solitary at each joint of the racemes, opening in succession as the racemes lengthen. Calyx funnel-shaped, 3-toothed at the mouth, about three-quarters of an inch long, striated with fine nerves, permanent. Tube of corolla slender, as long as the calyx; limb double, exterior of three oblong, concave, nearly equal, pale greenish-white divisions, inner lip obovate, much larger than the exterior divisions, somewhat curled at the margin with the apex slightly 3-lobed, marked chiefly in the centre with purple violet stripes. Filament short, erect. Anther double, emarginate. Ovary oval, smooth; style slender; stigma funnel shaped. Capsule oval, somewhat 3-sided, 3-celled, 3-valved. Seeds many, angular.

This plant grows abundantly, both wild and cultivated, in the mountainous forests north of the Kanara, Coorg and Wynaad on the Malabar coast, at altitudes of from 2500 feet to nearly 5000 feet above the level of the sea. In 1888 the crop occupied 899 acres. The cardamoms of the Wynaad, which are esteemed the best, are cultivated; the spots chosen for the cardamom farms are called *Ela-Kandy*, and are either level or gently sloping surfaces on the highest range of the Ghaûts after passing the first declivity from their base.* It grows in a perfectly wild state in the forests of Anamalai, Cochin, and Travancore, and between Travancore and Madura;† also at certain places in the hills which form the lower part of the Ghaûts in Cadutinada and other northern districts of Malayata.‡ Before the commencement of the periodical rains in June, the cultivators of the cardamom ascend the coldest and most shady sides of a woody mountain; a tree of uncommon size

* Trans. Lin. Soc., x. p. 237.

† Hamilton [Buchanan], Journey through Mysore, Canara and Malabar, ii. p. 336.

‡ Hamilton op. cit., ii. p. 510.

and weight is then sought after, the adjacent ground is cleared of grass and weeds and disencumbered of the roots of the brushwood. The tree is then felled, and the earth being shaken and loosened by the shock, sends forth young cardamom plants in about a month's time, they being produced from dormant seeds scattered on the spot or washed thither by rains from adjacent parts. (This curious process of inducing spontaneous germination is of course only effectual with the seeds of certain plants possessing the power of retaining their vitality in the earth for a long period and germinating under favourable climatic change.)

The shrub continues to grow until after the early rains of the fourth year, in February, when it has reached its utmost height, which varies from 6 to 9 feet ; four or five tendrils are now seen to spring from its stem near the root, and afterwards the fruit is produced, which is gathered the following November, and requires no other preparation than drying in the sun. The fruit is annually collected in this way until the seventh year, when it is usual to cut the plant down, and from the stump other sprouts arise in the course of the next monsoon, which grow, flourish and are cultivated as before.

Although the cardamom plant grows wild in the forests of Southern India, where it is commonly called Káchi, the bulk of the fruits of commerce are supplied from plants more carefully cultivated than above described. The method of cultivation varies with the locality. In the forests of Travancore, Coorg and Wynaad, where the plant is known to the natives as *Ailum chedy* (the Ailum shrub; the word is a corruption of the Sanskrit name of the plant *Ela*), the cultivators seek out, before the commencement of the rainy season, a suitable locality on the mountain side where the plant grows wild, under the shade of trees which do not shed their leaves. The ground is then to some extent cleared to allow the plants room for growth, and during the season they will attain a height of from 12 to 24 inches. The ground is then again cleared of weeds and fenced round. The plants will commence to flower in about two years from the time of first clearing the ground, and five months later some of the fruits will have ripened, but the greater part of them require a year to mature. The plants will continue productive for six or seven years. A plantation of 484 square yards (or a tenth of an acre) will yield on an average 12½ lbs. per year of pods. In an acre of forest land four such

clearings can be planted.* Ludlow, Assistant Conservator of forests, states,† that an acre of forest only produces 28 lbs. of cardamoms annually; he avers that the plants, which grow in the forest clearings of Coorg, are mostly wild and of the same spontaneous sort of growth as is developed by plants in clearings in European forests.

A writer in "The Planter's Gazette," states that the yield on good soil in Ceylon is about 130 lbs. per acre.

The work by Elliot, above referred to, contains valuable information, acquired by personal experience, concerning this cultivation, such as may ensure success to Colonists engaging in it, and he considers it a branch of industry worthy the attention of Europeans.

The following details were communicated to Messrs. Flückiger and Hanbury‡ by Col. Beddome, Conservator of Forests of Madras; information being also communicated to them by Dr. Brandis, Inspector General of Indian Forests, and Dr. King, Director of the Botanic Garden, Calcutta, and probably embodied in their valuable work:—"The cardamom is grown in shady localities on the lower slopes of the Pulney mountains, near Dindigul, at an elevation of between 4,000 and 5,000 feet above the sea. In the dense and always humid forests, known by the name of *Sholas*, the natives make clearings by burning all the underwood from beneath the trees and cutting down the smaller trees. The young cardamom plants then soon appear on the surface of the bare soil, and when they have attained a few inches in height are transplanted, either singly or in couples to beneath the shade of large trees. They do not bear fruit until five years old. (The temperature of the cardamom region averages 22° C., and the annual rainfall 119 inches)."

In the north of Kanara and in the west of Mysore the cardamom is cultivated in the Areca-nut plantations. The young seedlings are planted beneath the shade of these palms and bananas. They are said to produce fruit from the third year. The fruit of the cardamom begins to ripen in October and the harvest is gathered during the first two or three months of the dry season.

* Report on the Administration of Coorg for the year 1872-73, Bangalore, 1873, p. 44.

† Elliot. Experiences of a Planter in the jungles of Mysore, London, 1871, pp. 11, 201, 209.

‡ Hist. des Drogues, ii. 446.

The whole of the fruits on one stalk do not mature simultaneously, but the ripe and unripe are all cut together with the stalk, and in that state dried; of course to the detriment of the crop. This is done partly to avoid the fruit being eaten by serpents, frogs and squirrels, and partly to prevent the dehiscence of the capsules which takes place at the time of complete maturity. In some plantations, however, the harvest is collected in a more rational way.

As soon as gathered, the fruit is conveyed to the drying sheds and left exposed for a few days on mats. They are then detached from the stalks and the desiccation completed by suspending them in flat baskets over a gentle slow fire. In Coorg the pods are picked from the stalks previous to drying, which is effected entirely by exposure to the sun.

A writer in the "Tropical Agriculturist," 1st March, 1888, referring to the methods above-described for forming a cardamom plantation, says:—"The spontaneous way in which the plant was for a long time supposed to be *exclusively* produced, viz., from the concussion of the ground occasioned by the fall of a large tree felled over it, was probably a cunning idea suggested by the interested motives of those who were the fortunate holders of the cardamom hills and habitats, but there is no question of the fact that cardamoms can be reared from seed sown in shaded nurseries in the ordinary way, or from the division of the rhizome into parts containing young shoots or eyes fit for development into them. The former is undoubtedly the quickest way of forming a plantation; although it must be admitted the seed is singularly slow in germinating, taking never less than three and often as many as five months, before the little spikes show themselves above ground. Within a year from this time the plants will, with careful culture, have attained a sufficient size to be planted out into pits dug for their reception in the shade of the forest, suitably prepared by trenching, and the thorough extirpation of root and branch of the brush-wood occupying the surface. A moderate degree of shade and any amount of moisture are the climatic conditions most favourable for the plant's luxuriant growth. If the shade be too profound, the stalks which spring from the rhizome will be but few in number, but if sunlight be moderately admitted, they will increase amazingly, often exceeding 70 in number; yet, if exposed to sunshine for more than an hour or two daily, the plant languishes and eventually dies out. Each stalk throws out a

scape, varying in length from $1\frac{1}{2}$ to $2\frac{1}{2}$ feet, on which the fruit is produced in the form of capsules arranged in an alternate manner at a distance of $2\frac{1}{2}$ inches from each other. In its natural climate and soil, a sandy loam devoid of clay, the plant begins to bear in the second year, and yields a full crop in the fourth year. Owing to the large amount of moisture contained in the vegetable tissue of the capsules, one pound of the green fruit reduces down to one quarter and sometimes one-fifth of a pound when fully dried. Each stalk, as it completes its functions in bringing its scape to maturity, is succeeded by another stalk sprouting from the parent root, which begins to bear in the course of a year; and in this order the growth proceeds with successive renovations until the plant attains its ultimate span of existence, the extent or duration of which is not accurately known to the writer." "The process cardamoms are put through, called "bleaching," is a tedious one, and if left to agents, particularly costly. It is done by exposing them to the fumes of sulphur in closed receptacles, a process which has the effect of transforming their dingy grey into a delicate pale straw colour. This may be called one of the tricks of the trade, which, while perhaps it may not appreciably deteriorate or detract from the quality or flavour of the grains, captivates the public eye and secures a better price."

As regards the "bleaching" of cardamoms, Watt, in his "Dictionary of the Economic products of India," iii. p. 233, explains the matter very differently: he says, "Though local taste appears to prefer them unbleached, a good market is found for doctored cardamoms as far as Bombay and Bangalore, and for this purpose a considerable proportion of the cardamoms produced in Kánara is taken to Haveri and Dharwar to be bleached with the aid of the water in the well which is supposed to have the virtues of bleaching and improving the flavour of this fruit. The well belongs to a Jangam or Ling-ayat priest. He makes no charge for its use, though it is said he receives voluntary presents from the cardamom dealers. With a view to ascertain whether this well had really the virtues ascribed to it, samples of its water were subjected to analysis by Dr. Lyon, the Government Analyst and Dr. Cooke, Principal of the College of Science at Poona. Both reported that the so-called virtues of the water are totally fanciful The result of their analysis is as follows:—

Total solids by evaporation ...	427·00	Grains per Gallon
Chlorine..........................	110·60	„
Sulphuric acid	36·38	„
Salica	2·59	„
Alumina..........................	4·27	„
Lime	60·20	„
Magnesia	34·44	„

Mr. E. C. Ozanne, who in 1885 saw the whole process of bleaching, describes it as follows:—"Water from the well is drawn and taken to a suitable room. A large earthenware vessel is filled with the water, into which pounded *Antalkai* (the fruit of the "Soap nut," *Sapindus trifoliatus*) and *Sikikai* (*Acacia concinna*) in the proportion of 2 lbs. of the former to ¼ lb. of the latter for about every five gallons of water, are placed and well stirred. Another vessel contains a strong solution of common soap in the water of the well. The mixture containing 2 lbs. of pounded soap-nut and ¼ lb. of *Sikikai* is sufficient for 130 lbs. of cardamoms (5 *mans*; 1 *man* = 26 lbs). Two women seated on tripods, place a wide-mouthed earthenware vessel between them. Eight *lota-fulls* of the well water (of which a large supply is kept at hand) are poured into the tub, and three *lota-fulls* of the soap-nut *Sikikai* mixture (the *lota* holds about 1 quart). The tub then receives a basket-full of cardamoms weighing 10 lbs. The two women plunge their hands into the tub and stir vigorously for about one minute, and then suddenly rest for about the same length of time, then again stir for another minute. A thick lather results. This completes the first washing. The cardamoms are baled out by hand and transferred to a basket, where they remain a few seconds till the water has drained off. The basketful is received by two other women sitting on tripods with a tub between them. This tub contains 7 quarts of pure water, 1 quart of the soap-nut and *Sikikai* mixture, and one of the soap solution. The cardamoms are stirred as in the first washing, with the same interval of rest, and are baled out into another basket. When the water is drained off, the washed cardamoms are thrown on to a mat. The heap becomes large after a few hours' work. A woman is exclusively in charge of it and constantly sprinkles the well-water over it. She is relieved at night by another woman who sprinkles the heap till morning, once every half-hour. Next day, when the sun has risen, the heap is carried to the flat roof of the house and the cardamoms

are spread on mats for four or five hours to dry. The next operation is to nip off the short stalks. This is done by women sitting in the house. Eaeh woman has a large pair of English scissors. She squats on the floor and rests her right hand, whieh holds the scissors, on the floor, and feeds the seissors with her left hand. This work is done at an astonishing pace. The stalk is very small and care must be taken to cut it off without injury to the eardamom itself. I saw an old woman nip 90 cardamoms in one minute. This done, the sorting begins. The small, ill-shapen cardomoms are separated, and only the well-rounded ones packed for export to distant markets. A woman sorts a "*man*" *per diem* (26 lbs.). Returning now to the first proeess of washing. The mixture in the tub, after the first basketful has been baled out, is replenished by two or three quarts of the well-water and a second basketful washed. The tub is then emptied and a fresh mixture made. The mixture for the second washing also does duty for two basketfuls.

"Besides this bleaching process, eardamoms are now starehed. Starching was first introduced at Sirsi, where bleaehers had recourse to it as they had to compete with the bleachers at Haveri, who were experts in the art of bleaching and had established their fame as such. The starched cardamoms look whiter than the ordinary bleaehed ones of Haveri, and the bleachers of Haveri have now taken to starching. The starch is prepared by pounding together riee, wheat and country soap with butter-milk. The paste is dissolved in a suffieient quantity of water, and the solution sprinkled over the eardamoms to be starched as they are being rubbed by the hand."

As met with in commeree the Malabar cardamom is an ovate-oblong, obtusely triangular capsule, of variable size, eoriaeeous, ribbed, bluntly triangular, grey or brownish-yellow, opening longitudinally by three valves and eontaining five or six seeds in eaeh of its three eompartments. The shrivelled insipid periearp is striated lengthways. The seeds are reddish-brown, wrinkled, obtusely wedge-shaped and angular externally, somewhat resembling the dark sort of coehineal; they have a pleasantly aromatie odour and agreeable taste. Internally they are whitish. Good cardamom fruits should be plump and heavy, and should contain seeds to the extent of three-fourths of their weight.

Cardamoms vary in size, shape, colour and aroma. The sort most preferred are commercially known as "Malabar shorts," these are shortly ovoid, obtuse at the ends, or nearly globular, from three-tenths to half-an-inch in length. The second sort, called "Madras shortlings" or "Short-longs," taper to a point at the extremities, are lighter in colour and shipped at Madras and Pondichery; their length is from seven-tenths to three-quarters of of an inch. There is a sort called "Long-longs," but they are rarely imported. Another variety known as "Aleppy shorts" have a peculiar greenish tint and are imported from Calicut and Mangalore.

Cardamom seeds are best preserved in their pericarps until required for actual use.

The **Ceylon Cardamom** is the *Elattaria cardamomum*, Maton, *var major*,* sometimes referred to as *Var. β*, and called by the Singhalese *Ensal*. The plant is distinguished by its greater height and the elongated shape of its fruit. It was formerly described as a distinct species, under the name of *Elattaria major*, but on careful examination, it is not found to possess any botanical character warranting it being pronounced anything but a mere variety of the typical plant. It is only known in Ceylon. The capsule is lanceolate-oblong, acutely triangular, more or less curved, with flat and ribbed sides, about an inch-and-a-half or two inches long and about one-third to a quarter-of-an-inch broad. At one extremity is sometimes found the long, cylindrical, permanent, 3-lobed calyx, and at the other end the fruit-stalk, which is sometimes branched. The pericarp is coriaceous, tough, of a dirty white or yellowish ash colour, 3-celled. The seeds are larger and more numerous than in the Malabar variety, and are angular, rugged, of yellowish-red tinge and a peculiar odour and taste very distinct from the foregoing, having some resemblance to that of mace and elemi.

It should not be confused with the "Greater cardamom" of Bengal and Nepál, which is the *Amomum subulatum*, hereafter described.

The total area of land in India under cardamom cultivation

* Dr. Trimen, Systematic Catalogue of the Flowering Plants and Ferns of Ceylon.

cannot be definitely determined, though it may be affirmed that the crop is chiefly raised in the portion of the mountainous tract of the southern or south western extremity of the Peninsula. The chief districts in the Madras Presidency under this crop have been estimated as follows:—District of Madura, 1885-6, 1,200 acres; 1886-7, 1,000 acres; and 1887-8, 1,800 acres. South Kanara, 1885-6, 1,000 acres; 1886-7, 1,800 acres; and 1887-8, 1,400 acres. Malabar, 1885-6, 1,500 acres: 1886-7, 1,800 acres; and 1887-8, 2,000 acres. In Mysore, cardamoms are mainly grown in the Kadur district, the area under the crop having, in the corresponding years to the above been 1,600, 2,300 and 2,000 acres. In Coorg, the crop rarely occupies much over 300 acres. Thus, in Southern India, according to the published statistics, there were 5,590 acres in 1885-6 and 7,700 acres in 1887-8.

As regards the Ceylon production, the export from Colombo and Galle in 1888 was 287,724 lbs.; in 1889, 361,224 lbs.; in 1890, 387,940 lbs.; the estimated total harvest of 1891 is estimated at 400,000 lbs.; three-fourths of that amount being produced in the Rangala district.

Oil of cardamom seeds is largely distilled in Germany, principally, if not entirely, from *Elettaria cardamomum;*

The yield from the Ceylon fruit		being	2·5 to 6	per cent.
That from the	Madras	„	4·5 to 8	„
„ „	Malabar	„	4·2	„
„ „	Siam	„	4·3	„

The average sp. gr. of essential oil of Elettaria cardamom is 0·902 at 10°; 0·900 at 15° and 0·897 at 20° C. Flückiger gives its contitutional formula as $C_{10}H_{22}O_3$, and remarks that the water passing over during its distillation contains acetic acid.

The seeds also contain 10 per cent of fixed oil.

Korarima Cardamom which is the *Cardamomum majus* of Valerius Cordus,* Matthiolus, Geoffroy,† Smith‡ and Geiger.§

Pereira's information, furnished by Royle, and by Johnston indicate that this cardamom is supplied principally from Guraque

* Hist. Plant., lib. vi. cap. xxviii.

† Mat. Med., ii. p. 366.

‡ Rees' Cy. Art., "Mellegetta."

§ Handb. d. Pharm. Bd. ii.

and other countries situated in the south-western parts of Abyssinia. It is not improbable that it is the fruit which Speke saw growing in 1862 at Uganda.* The identity of the plant is, however, doubtful, and, as Muter observes in his "Key to Organic Materia Medica," "the natural history of this class of fruits has always proved a difficulty to pharmacologists" (an observation which could justly be extended to many other plants furnishing useful products). As stated by Pereira, the "Korarima" is brought to the market of Baso in southern Abyssinia from Túmhe, known among the native merchants as "the country of the Korarima," somewhere about 9° N. lat. and 35° E. long. It is carried to Massowáh, the port of northern Abyssinia on the Red Sea and exported from thence to India. The capsule is ovate, pointed, flattened on one side, striated, with a broad circular umbilicus or scar at the bottom, around which is an elevated, notched and corrugated margin. Some authors who have mistaken the base of the capsule for its summit, have compared the shape to that of a fig. The seeds are rather larger than Grains of Paradise, roundish, or somewhat angular, abrupt at the base, olive-brown, with an aromatic flavour analogous to that of the Malabar cardamom, but totally devoid of the vehemently hot taste of the Grains of Paradise.

A. cardamomum, Lin., sp. pl. 2. ed. i. 8, furnishes the "Round" or "Clustered Cardamom" which is the *Cardamomum minus* of Rumphius† the *ἄμωμον* of Dioscorides,‡ and the *Amomi uva* of Pliny.§ The plant is a native of Cambodge, Siam, Sumatra and Java. Its fruit is an article of commercial importance in the far East; the shipments from Bangkok being almost entirely to Singapore and China. The fruit is globular, varying in size from that of a black currant to that of a cherry. It is roundish or roundish-ovate, with three convex rounded sides or lobes, more or less striated longitudinally, yellowish or brownish-white, sometimes with a red tint. The seeds are brown, angular, cuneiform, shrivelled, aromatic and camphoraceous in flavour and odour;

* Journal of the Discovery of the Source of the Nile, p. 648 (appendix).

† Amb., v. p. 152, t. 65, f. i.

‡ Lib. i. cap. xiv.

§ Hist. Nat., lib. xii. cap. xxviii. ed. Valp. Pereira Mat. Med., ii. pt. i. p. 243.

they are used as a substitute for the true cardamom of Malabar, which they very much resemble. Its perennial root is creeping under the surface of the soil like that of ginger, but smaller, less fleshy, more ligneous and white; from which descend and spread many fleshy fibres. The stems are biennial, rising obliquely to the height of two or four feet, about as thick as a stout rattan, invested in the smooth deep green sheaths of the leaves. The leaves are alternate, bifarious, short-petioled on their smooth stem-clasping sheaths; from broad-lanceolate below to narrow-lanceolate at top, entire and smooth on both sides; point long and very fine; length from six to twelve inches. The spikes are radical, sessile, oblong, appearing amongst the stems, half immersed in the earth, loosely imbricated with one-flowered, lanceolate, acute, villous, nervous, scariose, ash-coloured bractes; when old, their brittle tops are often broken off. Besides the exterior one-flowered bractes just mentioned, there is an inner striated, downy, scariose, two-toothed tubular one, inserted round the base of the germ. The flowers open in succession and are not very conspicuous. The calyx is clavate, tubular, downy, three-toothed, length of the tube of the corolla which is slender and slightly incurved. The exterior border of the corolla is sub-equally divided into three pellucid divisions. The lip or inner border is rather longer than the exterior great border, somewhat three-lobed, with a crenate curled margin; the middle lobe is yellow, with two rosy lines leading up to it from the mouth of the tube. The filament is scarcely half so long as the border of the corolla, incurved over the mouth of the tube. There is a subulate horn on each side of the base of the filament (as in *A. maximum*) and nearly its length. The anther is double, large, fleshy, with a large three-lobed concave crest, the stigma rising through a deep groove between the two polleniferous lobes. The germ is downy and crowned with the two nectarial scales within the base of the tube of the corolla; in this species they are short and truncated.

A. Maximum, Roxb., "Flor. Ind.," i., p. 41. "Java Cardamoms" or "Great Winged Cardamoms." These fruits are about the size of a gooseberry, growing in bunches of 30 or 40 on a short thick stalk. Each fruit is furnished with 9 or 10 prominent, short, coarsely dentate membranous wings about an eighth of an inch deep, arranged in rows lengthways. The seeds are somewhat

larger than Grains of Paradise, angular, dull dirty-brown, with a shallow groove on one side, internally white, of aromatic taste like cardamoms, but less powerful. The leaves of this plant are alternate, petioled, lanceolar and linear-lanceolar, acute, smooth above, villous beneath, with many large parallel veins; from two to three feet long and about six inches broad; when dry the underside appears to be more closely covered with most beautiful soft sericeous down than when fresh. The floral spikes are radical and short, their flower-bearing apex being only just above the earth; below the flowers they are covered with large oval concave scales. The exterior border of the corolla is three-bordered as usual in the genus, but in this species they all converge upward into one helmet over the anther and stigma. The labellum is entire, expanding, oblong, marked with a yellow stripe down the middle, its margins are waved and crenulate. The staminal filament is short. From the mouth of the tube of the corolla, opposite to its interior border, on each side of its insertion, is a small hornlet. The anther double or two-lobed and crowned with a beautiful broad semi-lunar crest. This plant is cultivated in Java for the sake of the very agreeable flavour of the pulp of its fruit.

A. aromaticum, Roxb., "Flor. Ind.," i., p. 44. "Bengal Cardamoms." This species was confounded by Pereira with *A. cardamomum* Lin. and *A. xanthoides,* Wallich, also with *A. maximum,* Roxb., above described. It is a native of the valleys on the eastern frontier of Bengal, where it blossoms during the hot season, before the periodical rains begin, and the fruit ripens in September, when it is carefully gathered by the natives and sold to the druggists as "*Morung elachi*" or "cardamom," though the seed vessel of this species is very dissimilar in form to that of other species. The seeds however are similar in shape and spicy flavour. The Bengal cardamom is about an inch in length, ovoid, and imperfectly triangular and somewhat conical in shape; its lower extremity is rounded, and, as met with in commerce, generally devoid of stalk. On the upper half of the capsule are nine membranous wings which are very apparent when the dried capsule is soaked in water. The capsule terminates in a truncated silky nipple, never extending as a tube. The pericarp is coarsely striated and of a dark brown colour, which distinguishes it from

A. maximum. Its three valves very easily split open, disclosing from 60 to 80 seeds arranged in the three lobes and agglutinated together by a sticky saccharine pulp which constitutes the arillus enveloping each seed. The seeds are roundish oval or obovate, but angular by reason of pressure against each other; their odour and taste is very aromatic and camphoraceous.

The roots of this plant are tuberous, as in other species. The stems are in tufts, more or less oblique according to their situation in the tuft, those in the centre being nearly erect, while on the outside they bend out considerably; all are covered with the sheaths of the leaves; their general height is two or three feet. The leaves are lanceolate, acuminate, smooth, from ten to twelve inches long and from two to four broad. The spikes are radical, imbricated, at first clavate, afterwards becoming roundish as the fruit matures. The pale-yellow flowers are of medium size, each emerging from the axil of an oblong, smooth, concave bracte. The calyx is cylindric, entire or dentate, villous; the corolla is formed of a long slender tube of three sub-lanceolate obtuse segments, the upper one somewhat recurved over the stamina and stigma. The lip or labellum is nearly round and is undivided; it is tinged with red down the middle, having no spurs or projections between it and the base of the filament. The filament is linear and incurved. The anther is crowned with a three-lobed crest.

A. subulatum, Roxb. "Flor. Ind," i., p. 42, furnishes the "Nepal cardamom," which, in the state it is met with on the market very much resembles the "Bengal" sort, the seed pods being of the same size, shape, and outward appearance, the seeds also being of the same shape and aroma; the principal difference consists in its being surmounted with a tabular calyx as long or longer than the fruit itself; another difference being that it frequently has a short stalk attached. The plant is a native of the lower range of mountains which skirt the plains of Bengal on the north, where it grows on the banks of the brooks between the hills. It is cultivated near Darjiling on the Nepal frontier, where it attains a height of from three to five feet on the well watered mountain slopes and beneath the shade of trees. The radical, compact spikes, which are but little elevated above the soil, are obovate, with long subulate bractes and dark red in colour. The flowers are yellow and large, with an oblong labellum, the anthers are crowned with

an entire crest. The fruits of this species form in clusters and their oval bractes are narrower than those of *A. aromaticum.*

Amomum medium, Loureiro, Flor. Cochinch; Syn. *Alpinia alba*, Roscoe; *Hellenia alba*, Willd.; *Heritiera alba*, Retz.; *Languas vulgare* and *Galanga alba*, Kœnig.* Specimens of this fruit are in the Museum of the Pharmaceutical Society. It is the "ovoid China cardamom," described and figured by Guibourt,† who states that it is identical with the specimen labelled *Tsao-quo* in the Museum of Natural History in Paris. The dried fruit is about the size and shape of a nutmeg, yellowish grey (Kœnig says scarlet when recent). The seeds are larger than in any other kind, dull, angular and somewhat pear-shaped. In the catalogue of the Museum of the Pharmaceutical Society these seeds are stated to have "an aromatic taste like that of oil of lemon-grass, but much less powerful than those of *A. citratum.*" There is an analagous fruit in the Museum of Natural History, Paris, labelled *Quà-leu.*

The plant grows in the Province of Yu-nan.

Amomum citratum, Pereira. Mat. Med., ii., pt. i., p. 251, fig 110.‡ A specimen of this fruit in the Museum of the Pharmaceutical Society is of a deep purplish-brown colour. The seeds are angular, oblong, larger than those of Malabar cardamoms, shining, brownish-yellow, and have a large concave depression (hilum) at one extremity. The seeds have a warm aromatic flavour analagous to that of oil of lemon-grass or verbena, much more powerful than in *A. medium*; they are distinguished from the seeds of that drug by being silky, more shining and of darker brown colour. The fruits in the Sloanian collection of the British Museum, marked in the catalogue 12057 "Grana Paradisi," belong to this species.

Amomum cerum, Hooker fil.; Syn. *A. palustre*, Afzelius. Figured and described by Daniell in Pharm. Journ. [1] xvi., pp. 515 and 516. The powdered seed is made into an ointment and used as a perfume by the Timneh women in Sierra Leone.

Amomum macrospermom, Smith. The "Large-seeded Guinea cardamom." The fruit, *Zingiber Meleguetta*, Gærtner de

* Pereira, Mat. Med., ii., pt. i., p. 257, fig. 126; Pharm. Journ. [1], xiv., p. 420, fig. 9.

† Hist. des Drogues, 7 edit., ii., p. 218.

‡ Pharm. Journ. [i] ix., p. 313.

Fruct., i., p. 34, t. xii., fig. i; *Fructus Cajuputi*, Trew, Commercium Litterarium Nurimbergæ, p. 129, t. 1, fig. 7-11; *Cardamomum bandaense* Martius; *Mabooboo* of the natives of Sierre Leone and *Palancupon* in the Mandingo language. It is found at Coto, Cape St. Mary and Gambia. This fruit is ovate, pointed, somewhat striated, about two inches long. It is figured in Pereira, Mat. Med., ii., pt. i., p. 253. The seeds (*semina cajuputi*), Trew, are about the size of Grains of Paradise, ovate, or somewhat oblong, or nearly globular, polished and variously angular, of a greenish-grey or leaden-grey colour, with an umbilicated scar surrounding the hilum. The seeds yield a volatile oil by distillation in the proportions of about 3 drachms to a pound;* this is pale yellow, aromatic and camphoraceous, resembling cajuput oil, but less penetrating. The white-purplish flowers of the plant are stalked (in this respect differing from those of *A. Melagueta*).

"Bastard Melligetta" is the common name of *Amomum angustifolium*, Sonn.; Syn. *A. nemorosum* Boj.†; *A. Danielli*, Hooker fil. The drawings made from Daniell's specimens are reproduced by Pereira in his Mat. Med., ii., pt. i., p. 252. It very nearly resembles *A. Clusii*. It is a native of the Gold and Slave Coasts, and abundant at Fernando Po and Clarence Town. This tall and handsome species grows from 8 to 9 feet high. The flowers produced in June and July are of a beautiful yellow colour,‡ thus differing from the true Melligetta and other West African Amoma.

Other species yielding products analogous to Cardomoms, little known in commerce, and imperfectly described botanically, are:—

A. racemosum, Clusius,§ producing globular fruit in bunches; a native of the Moluccas.

A. globosum, Loureiro, the "Chinese round cardamom," *Cao-Keu*, of which there are two varieties; the "Large round" and the "Small round."‖

A. villosum, Loureiro, or "Hairy China cardamom" of Guibourt. *Yang-chun-sha*. ¶

* Cartheuser Dessert. nonnullæ select. physico-chem. ac medicæ.

† Pharm. Journ. [i.], xiii., p. 639.

‡ Pharm. Journ. [i.], xii. p. 72.

§ Exoticæ, p. 377, and Blackwell's Herbarium, t. 371.

‖ Guibourt. Hist. des Drogues, ii. p. 217.

¶ Pharm. Journ. [i.], xiv. p. 355, fig. 45.

A. Xanthoides, Wallich, "The Bastard cardamom of Birenah and Siam"* is a native of Tenasserim and Siam. For many years the seeds of this plant have been taken out of their shells previous to exportation and shipped to London, where they are known on the market as "Cardamom seeds," and occasionally Wild or Bastard cardamoms; they are also very common in the bazaars in India.† They also form an important article of commerce in Siam. They somewhat resemble the seeds of Malabar cardamoms in appearance, but differ in odour, which is powerfully camphoraceous. The spines on the pods are larger than on *A. Villosum*.

In the collection of drugs exhibited by the Chinese Imperial Maritime Customs at the Philadelphia Exhibition in 1876, were fruits of the "Bitter-seeded cardamom," catalogued as derived from *A. amarum* from Kwangtung Province. The characters expressing the Chinese name of this drug indicate its property of strengthening the stomach; the strength of which organ is considered by the Celestials as indicative not only of a person's disposition, but of his mental capacity. The market price of the fruit of this species is accordingly high—20 dollars per pecul at Canton; the fruit of *A. globosum* being quoted 8½ dollars.

Much valuable information on rare forms of cardamoms is given in "Hanbury's Science Papers."

Coriander.

The product known as Coriander "seeds" consists of the dried ripe fruit of *Coriandrum sativum*, Lin., which is the only species of this genus of *Umbelliferæ*. ‡

It is an annual herb, about two feet in height, with a branching stem. The leaves are bipinnate, the lower ones divided into broad or wedge-shaped, deeply-cut segments, while the upper ones are more finely cut. The umbels have five to eight rays without a

* Ibid, pp. 417, 418, fig. 67.

† Modeen Sheriff, Supplement to Pharmacopœia of India, pp. 44, 270.

‡ Martin, Flora rustica, t. 141; Morison, Plantarium Historia, iii., p. 269, Sec. ix., t. 11, f. 1; Bentley and Trimen, Med. Plants, t. 133; Sowerby, Eng. Bot. 67; Stevenson and Churchill, Med. Bot., t. 94; Sibthorp, Flor. Græc., t. 283; Baillon, Hist. Plant., vii., figs. 134-8.

general involucre, and the partial ones consist of only a few small bractes; the flowers are whitish or pink. The most characteristic feature is the globular fruit of chamois colour or pale yellow, about the size of a white peppercorn, which is crowned by the teeth of the calyx, and has no oil channels on the outer surface, but two on the inner face of each half of the fruit; the ridges are five in number and rather indistinct. As the two carpels of which the fruit is composed do not readily separate one from the other, being protected by the ligneous pericarp, the fruits must be broken before submitting them to distillation. The unripe fruits possess the intensely disgusting odour of the other parts of the plant; it is therefore necessary to await their complete maturity before gathering them. The nature of the chemical action producing this modification in the odour is not understood.

Although a native of the Levant and Southern Europe, it is cultivated and even sometimes found in a half-wild condition in this country.

In England the seeds should be sown in September, in drills a foot apart, preferably in a light rich soil. When the young plants appear, they should be thinned out to a distance of 6 or 8 inches apart. In the spring, the earth should be gently stirred with fork or pronged hoe, and the weeds kept down. It is estimated that from 15 to 20 lbs. of seeds will set an acre. The flowers begin to show about June and the seeds ripen in August; they must be gathered with care to avoid loss by dropping. If the seed-bearing part of the plants be clipped off and at once put into bags, less seed will be dropped than by cutting down the entire plants. The seed is separated out by a few strokes of a flail, a sail-cloth being spread beneath.

The English cultivation is mentioned by Baker in Morton's Cyclopædia of Agriculture, i., p. 545; the average yield from good soil in England is 15 cwt. per acre.

In India and Morocco it is also largely grown, although the fruit produced in those countries is poorer in essential oil than that grown in more northern countries. The Hindee name of the plant is *D'haynyà.**

* Roxb. Hort. Beng., p. 21, and Flor. Ind., ii. p. 94; Wight, Ill., t. 117, fig. 9, and Icones, t. 516; Bois, Flor. Orient., ii. p. 920.

Indian coriander is a more elongated shaped fruit, about twice the size of the European kinds, and of little value to the distiller by reason of its small yield of oil. As a cultivated plant, it has spread over most of the warm countries of the globe, Egypt, Nubia, Abyssinia (where it is much used), North India, China, Japan and both North and South America.

In distilling the recent fruit it is necessary to be sure that it is all mature, as in the unripe state it has, like the whole plant generally when fresh, a very offensive odour, which has been compared to that of bugs.

It is estimated that the yield of oil from—

Thuringian seed is	0·6 to 0·8	per cent.
Moravian	0·8	„
Russian	0·8 to 1	„
Dutch...............	0·6	„
East Indian	0·2	„
Morocco............	0·2 to 0·3	per cent.
Italian	0·5	„
French	0·4	„
Mogodor.....	0·6	„

The seeds also contain 13 per cent. of fixed oil.

The very pleasant odour of the ripe fruit is intensified in the essential oil. In a dilute state the odour is not very unlike that of orange flowers; possibly on this account a colourless oil of sweet orange is often used as an adulterant; this is detected by the adulterated specimen being less soluble in alcohol of 90 per cent.*

An excellent indication of its purity is the fact that the pure oil affords a perfectly clear solution with three times its volume of 70 per cent. alcohol. The sp. gr. of pure oil of coriander appears to vary according to its origin between the limits of 0·874 and 0·882 at 15° C. Its optical rotation also varies from + 4° to + 13°†.

* See 1st Series, p. 76.

† Schimmel, Bericht, October, 1893.

The investigations of Semmler,* show that its principal constituent, amounting to 90 per cent. is an alcohol, $C_{10}H_{18}O$, which he named *Coriandrol*; this boils at 194°-198° and is optically dextro-rotatory, and has a sp. gr. of 0·8679 at 20° C. Recent investigations have been made† to determine the nature of the other constituents of Coriander oil; the first portions that distilled over on rectification with steam were repeatedly fractionated with the aid of a Lebel-Henninger's column, and finally a fraction was obtained boiling between 156°-160° C., with a sp. gr. of 0·861 at 15° C. In a 100 m. m. tube this showed an optical rotation of + 32° 42′. The nitrosyl-chloride compound yielded with benzylamine, a base with the melting point of 123°-124° C., so that it evidently consisted of Pinene-nitrolbenzylamine. Coriander oil therefore contains Dextro-pinene, the quantity of which is estimated at about 5 per cent.

According to a recent paper by Barbier,‡ coriandrol when treated with acetic anhydride, gives rise to a dextro-rotatory *limonene,* of which the physical and chemical properties are identical with those of *licarene* (a dextrogyre variety of *linalöol*), together with an acetic ether of a stereo-isomeric alcohol corresponding to *licarhodol* and apparently identical with it. Barbier considers therefore that coriandrol is but a dextro-rotatory modification of *licareol,* differing in odour, but otherwise possessing similar properties. The aldehyde *(citral)* formed from it by oxydation is apparently identical with that derived from licareol, and the evidence tends to prove that this alcohol exists in the two modifications, differing in the direction of their rotatory power, but otherwise practically identical.

The frequency with which adulterated coriander oils occur, especially in the American markets, renders it desirable to place within the reach of consumers an easily applicable test for the recognition of added foreign matter. The property of coriander oil to dissolve in dilute alcohol offers a good starting point to judge of its purity. Messrs. Schimmel & Co. state§ :—"Genuine coriander oil should yield a clear solution when mixed with three

* Ber. Deutsch, Chem. Ges., xxiv. p. 206.

† Schimmel and Co., Bericht, April, 1892.

‡ Comptes Rendus, cxvi. [1893], p. 1459.

§ Bericht, October, 1893.

parts of 70 per cent. alcohol at 20° ; additions of oil of turpentine, cedar-wood oil, &c., betraying themselves by their insolubility."

Caraway.

The common name "Caraway," or "Carraway," is given to the dried fruits of *Carum Carui*, Lin., a biennial umbelliferous plant inhabiting moist low-lying land in many parts of Northern and Central Europe. On such land it is cultivated in England in Essex, Kent, Lincolnshire and Yorkshire. Both in the wild and cultivated state it is also met with in Iceland,* Scandinavia, Finland, Russia, Siberia, Moravia, Prussia, the Pyrenees, Spain, Armenia and the Caucasus. It is found wild in great abundance in the high region of Lahul in the Western Himalaya,† and so widely is this plant (usually found in cold climates) distributed, that it is found largely grown in Morocco, particularly in the neighbourhood of Larache, the product being shipped at Tangier to England and America. It is also produced round Morocco city, there forming a plant four feet in height. At Mogador it is called "Fez Carraway seed." The Morocco seed is longer and paler than the ordinary seed. The oriental names of carraway indicate that it is not indigenous to the East, thus it is found designated as "Roman Cumin," "Armenian Cumin," "Mountain, or Foreign, Cumin," "Persian and Andalusian Caraway," and "Foreign anise."

The English name Caraway and the Spanish name Alcarahueya are derived from the name given to this fruit by the Arabs, *Karawya.*

The root of the plant is like a parsnip, but much smaller, running deep into the ground, sending out many small fibres, and having a strong aromatic taste. The upper part of the plant resembles that of a carrot, and the leaves are sometimes used as a flavouring in cookery, in the same way as parsley. The roots are said to be superior in flavour to those of a parsnip.

The mericarps (half-fruits), which either hang loosely to the carpophore, or are altogether separated, are about one sixth of an inch long and one twentieth of an inch in diameter. They are

* Journ. Linn. Soc. Bot., xi., p. 310.

† Ibid., x., pp. 76, 94.

slightly arched, with five pale coloured, equal, filiform ridges, and dark-brown channels between them, with one vitta in each channel. A pair of vittæ are also visible on the commisure.

The Caraway plant appears to prefer a moist soil. It is possible that it was originally an aquatic plant. George Henslow, in a paper read before the Linnean Society, 17th November, 1892,* on "A theoretical origin of Endogens from Exogens through Self-Adaptation to an Aquatic Habit," states:—"*Carum Bulbocastanum* and *carum carui* are not aquatic plants, but there are reasons for thinking that these two species, as well as other umbelliferous genera, characterised by their having *linear cotyledons* and *finely dissected foliage*, may have been so ancestrally. Such are, for example, *Cuminum Cyminum*, *Myrrhis odorata*, *Meum athamanticum*, *Scandix Pecten-Veneris* and Fennel; as well as the linear-leaved or phyllodinous *Aciphylla squarrosa* and species of *Bupleurum*. The resemblance of the cotyledons to that of *Ranunculus heterophyllus* is very marked; while *Œnanthe Phellandrium* furnishes both kinds of dissected foliage, the submerged and the aërial, and thus shows how the above-named terrestrial plants may have been aquatic at first."

In England it is generally cultivated in clay soils, and the seed was formerly sown with that of coriander† and teazle, but this system of cultivation is not advantageous. The best season for sowing the seeds is in Autumn, soon after they are ripe. They will then flower the succeeding June and ripen seed in July. When the seeds come up they must be thinned out in the same manner as practised for carrots, leaving them three or four inches apart. They then require to be kept very clean of weeds. After the harvest the seeds are threshed out in the same way as those of coriander.

The yield of seed from very rich ground is about twenty hundredweights to the acre. In poor dry land it may not exceed half that quantity. Heavy rains during the flowering time cause a great diminution in the yield of seed.

The seed is known on the market as English, Dutch, German, Mogodor, &c.; the English being the most esteemed in England, though not equal in delicacy of odour and flavour to the Dutch.

* Journ. Lin. Soc. Bot., xxix. p. 485.

† Morton Cyclo. of Agriculture, i. p. 390.

The yield of volatile oil from the different growths of seed is as follows:—

Dutch, cultivated	4 to 6·5 per cent.
„ „ near Leipzig..	4 to 4·3 „ „
German „	3·5 to 5 „ „
East Prussian „	5 to 5.5 „ „
Bavarian, Wild	6·5 to 7 „ „
Wurtembergian, Wild ...	5·5 to 6 „ „
Tyrolese, Wild	6·5 „ „
East Frisian, Wild	5·5 to 6 „ „
Styrian	6 „ „
Galician	4·5 „ „
Moravian	4 „ „
Norwegian, Wild	5 to 6·5 „ „
Swedish „	4 to 6·5 „ „
Finnish „	5 to 6 „ „
Russian „	3·2 to 3·6 „ „
Hessian „	6 to 7 „ „

The sp. gr. of these oils varies from 0·905 to 0·915 at 15° C., and the optical rotation from + 75° to + 85° in 100 m. m. tube.

Part of the acreage under cultivation for 1893 is estimated as follows:—

In the Province of North Holland ...	1250 acres
„ Groningen	250 „
„ Zealand	375 „

or about the same as 1892. In Germany, the cultivation is decreasing in consequence of the excessively depressed price of the seed not giving sufficient profit to the cultivator.

An inferior oil is distilled from the husks and refuse collected after threshing the fruit. It is known as "Carraway chaff oil" and is only suitable for perfuming common soaps.

Oil of Caraway is frequently adulterated with oil of turpentine, in which case it forms a turbid mixture with alcohol of 90 per cent.

Oil of caraway is composed of a mixture of *Carvol* $C_{10}H_{14}O$ and *Carvene* $C_{10}H_{16}$, the carvol generally amounts to two-thirds, but as the proportion is variable, the boiling point and sp. gr. of the crude oil also vary. The two bodies can be separated by fractional distillation, but a quicker and easier way is to agitate the

crude oil with an alcoholic solution of sulphide of ammonium; sulphydrate of carvol is then formed, and this compound, decomposed by ammonia, yields carvol.*

The sp. gr. of carvol is 0·963 at 15° C., and its boiling point 227° C., but the temperature gradually rises owing to partial decomposition caused by heat.

Carvene boils at 173° C., is colourless, mobile and lighter than water. It has the property of absorbing hydrochloric acid gas forming a pure white crystalline compound which melts at 50·5° C., but re-solidifies only at 41° C.† (This may be an error as regards point of solidification, see Anise oil).

This bi-chlorhydrate, $C_{10} H_{16}$ 2 H Cl. is very soluble in water, but its solution is decomposed by heat. It is also decomposed by sublimation.

Carveol or *Carvyl alcohol* is formed by the action of sodium on an alcoholic solution of carvol; it is a viscous liquid, differing in odour from carvol.

Carvene is obtained in large quantities as a by-product in the separation of Carvol from oil of caraway. It is not suitable for perfumes or liqueurs as it is insoluble and does not possess that delicate odour and taste peculiar to carvol, but it can be satisfactorily employed instead of caraway oil in perfuming soaps of medium and cheap quality.

The value of oil of caraway depends on the percentage of carvol contained in it. Messrs. Schimmel & Co. state that the products brought into commerce under the name "Carvol" are frequently caraway oil from which a portion of the carvene has been removed by fractional distillation. As a means of determining the purity of carvol, they indicate its solubility in 50 per cent. alcohol as follows:—Pure carvol dissolves at 20° C. in the proportion of 1 part by weight in 16 to 17 parts by weight of 50 per cent. alcohol. A sample of carvol to which 2 per cent. of carvene had been added, did not dissolve clear in 20 parts of 50 per cent. alcohol at 20° C. It is of importance to use alcohol of exactly this strength for the test, or at any rate not stronger, because with a higher concentra-

* Sulphydrate of carvol crystallises from solution in alcohol in long needles having the lustre of satin; these are fusible, and when cautiously heated, sublime almost unaltered.

† Schweizer, Journ. f. Prakt. Chem., xxiv., p. 257.

tion of the alcohol, the solubility of carvene increases rapidly in a disproportionate degree.

Both carvol and carvene are strongly dextrogyre, the latter remarkably so.

Carvol is identical with the carvol of Dill, but rather more strongly dextrogyre and can only be recognised by its optical power from the carvol of spearmint, which is lævogyre.*

Oil of caraway also contains *Carvacrol* $C_{10} H_{15} O H$, isomeric with thymol and very nearly related to it. It can be separated by treating oil of caraway with potash,† or by treating the same with iodine, cohobating several times and washing the product with potash; as then obtained, however, it is mixed with carvene.

Carvacrol can be obtained by heating a mixture of 50 grams. of carvol, 50 grams. of cumin oil and 12 grams. glacial phosphoric acid to boiling point for three or four hours; then pouring off the thick liquid and isolating the carvacrol by fractional distillation. It is also formed by melting *sulphonic acid* with caustic potash and is found among the products of the action of iodine on camphor. Carvacrol is the principal constituent of oil of *Origanum hirtum* (erroneously called " Spanish Hops,") and occurs largely in oil of *Satureja hortensis* (" Pepper-wort.")

Carvacrol, when pure, is a colourless viscid liquid lighter than water and soluble in water to a certain extent. Its odour is by some people considered very acrid, unpleasant and persistent; by others it has been considered analogous to that of Russia leather, —the very faint similarity is very distant—even when much diluted; but in any case it is very powerful and persistent. Carvacrol boils at 232° C., giving off vapours which irritate the organs of respiration. It burns with a bright and very smoky flame.

Dill.

This peculiar name is probably derived from the ancient Norse word *Dilla*,‡ in allusion to the carminative properties of the drug;

* Further investigations into the nature of carvol and its derivatives have been made by Wallich and quite recently by Baeyer (Ber. Deutsch. Chem. Ges., xxvi., p. 820).

† Zeitschr, f. Chem. [2] iv., p. 730.

‡ Prior, "Popular names of British Plants, 1870.

but in any case the word dates back to the tenth century, being found in the vocabulary of Alfric, Archbishop of Canterbury.* It is the Anise of St. Matthew, xxiii. 23.

The annual umbelliferous plant producing this aromatic fruit has for many years been known botanically as *Anethum graveolens*, Lin., but the generic name *Anethum* is now suppressed by Bentham and Hooker,† and this plant, the sole representative of the genus *Anethum* is included in the genus *Peucedanum*, and is now styled *Peucedanum graveolens*, Benth.‡ It is very indigenous to Central and Southern Europe, but is found abundantly in many countries, extending from Spain to the Caucasus and Persia, and southward into Egypt and Abyssinia. In England, it forms a plant somewhat resembling Fennel, of about two feet in height, with a smooth, but finely striated stem. The leaves are tripinnate, with fringe-like segments and very broad sheaths. It is distinguished amongst umbelliferous plants by the absence of involucre to the umbel, by the absence of the limb, or upper part of the calyx, by the fruit being flattened from back to front, provided with a membranous border or wing, and with six ridges, three on each half of the fruits. In each of the furrows between these ridges, is placed a broad channel or vitta, filled with volatile oil.

In Europe the seeds are sown in the autumn in light soil, and the young plants are thinned out in the early spring, so as to leave 10 inches between each plant.

Under the Hindustanee name *Suvà* or *Sóyah* it is cultivated in various parts of India, and in that climate rapidly attains a height of about three feet. By reason of a slight peculiarity of the fruit, the Indian plant was considered by Roxburgh § and De Candolle‖ to be a distinct species, *Anethum Sowa*, but it has no botanical characteristic sufficiently pronounced to alienate it from the ordinary *Anethum graveolens*.¶ The plant cultivated in India differs only in its rather longer and more narrowly winged fruit,

* Volume of Vocabularies, edn. Wright, 1857, p. 30.

† Genera plantarum, i., p. 919.

‡ Oliver, Flor. Trop. Africa, iii., p. 19.

§ Flor. Ind., ii., p. 96.

‖ Prodr., iv., p. 186.

¶ Bentley and Trimen, Med. Plant., t. 132.

the mericarps being narrower and more convex than in the European variety. The Abyssinian plant is a rather small form.

The fruit (erroneously called the seed) yields on distillation with water a fragrant essential oil. The average yield from German seed is 3·8 per cent.; from Russian, 4 per cent.; from East Indian, 2 per cent., and from Roumanian, 3½ per cent. The average sp. gr. of the oil is 0·910 at 15° C. Its optical rotation is + 70° to 80,° but that of East Indian is only + 41° 30′. According to the investigations of Nietzki,* Dill oil yields on fractional distillation, 10 per cent. of a hydrocarbon, $C_{10}H_{16}$, boiling at 155°-160°; 60 per cent. of a hydrocarbon of the same composition boiling at 170°-175,° and 30 per cent of *Carvol*, $C_{10}H_{14}O$, identical with the carvol of caraway oil, although not quite so strongly dextrogyre. The odour of the portion boiling between 170°-175° is described as in no way resembling that of dill, but exceedingly like that of oil of mace. The characteristic odour of dill was, however, immediately restored by the addition of carvol.

Indian dill fruit yields an oil of different and less pleasant odour and different chemical constitution; it is also heavier than that produced in other countries.

Peucedanum grande, C. B. Clarke. This plant is an inhabitant of the hills of Western India. Its fruit is known in the Hindee and Bombay vernacular as *Dúkú*. Dr. Dymock states† that the fruit of this plant has been adopted in India as a substitute for the Daucus seeds of the ancients, which were obtained from a species of Athamanta growing in Crete. This adoption was probably due to the early visits of Greek travellers and traders to Thana, and to the subsequent resort to the same port of the Mohamedans early in the 14th century. The plant is common on the hills of the Concan, and was probably brought for sale to Thana in those days, as it still is at the present time. In Royle's Materia Medica, Falconer is quoted as describing Dúkú as a fruit resembling that of Asafœtida, and as probably derived from some species of *Ferula*; this is just such a fruit. Other umbelliferous fruits are not unfrequently substituted for this drug.

The height of the plant is from three to seven feet, having very much the appearance of a garden parsnip which has run to seed;

* Archiv. der Pharm. [3], iv., p. 370.

† Pharmacographia Indica, ii., p. 126.

root large, perennial, all quite smooth; leaves mostly radical, long-petioled, bipinnate; leaflets trilobate; lobes large, rounded; margins crenate-serrate, shining on both sides; cauline leaves 1-2, biternate; stem round, smooth, striated, involucre and involucel leaves oblong or obovate, obtuse, partial rays numerous, many flowered; flowers yellow; fruit large, broadly elliptical, varying in size, the largest are $\frac{5}{8}$ of an inch long and $\frac{3}{8}$ broad; foliaceous, convex in the middle, with a dilated border, consisting of coarse cellular tissue; colour reddish-yellow over the seed, margin pale yellow; dorsal ridges seven, the three central filiform; vittæ in dorsal furrows 10 to 13; vittæ of commissure 6. The fruit has a *powerful lemon odour* with a soupçon of carrot.

As regards the chemical constitution of the fruit, the authors of the "Pharmacographia Indica" report as follows:—Twenty-five pounds of the fruit distilled with water yielded 6 fluid ounces of a light yellow essential oil having the odour of the fruit; it was dextrogyre, a column of 100 m. m., rotating 36 degrees. The sp. gr. at 15°·5 C, was ·9008. Cooled to —14° C., it was still liquid and no crystals separated. After dehydration, the oil commenced to boil at 76° C., the temperature rapidly rose to 100° C. when a few drops distilled over; the temperature continued to rise rapidly to 185° C.; up to this temperature 2 per cent. had distilled over. The subsequent progress of the distillation is tabulated as follows:—

2nd fraction ...	185° to 190° ...	17	per cent.
3rd " ...	191° to 196° ...	15	"
4th " ...	196° to 200° ...	12·5	"
5th " ...	200° to 205° ...	9·6	"
6th " ...	205° to 210° ...	6·4	"
7th " ...	210° to 220° ...	4·5	"
8th " ...	220° to 225° ...	4·0	"
9th " ...	225° to 228° ...	3·0	"

The residue left in the flask boiled constantly at the last recorded temperature and amounted to 26 per cent. The fractions up to the 6th were colourless, those below of a yellow colour. The residue in the flask was viscid and of a deep yellow tint. Treated with reagents, the oil in its original state (the crude oil), afforded the following reactions:—

Bromine dissolved in chloroform, at first nearly colourless, turning to dirty brown with a tinge of red, and finally to a dirty sage-green.

Concentrated sulphuric acid, deep orange to red.

Frohde's reagent, yellow, deep brown, violet to deep blue, the changes in colour being extremely rapid.

Nitric acid gave a yellow coloration.

Picric acid dissolved in the oil.

With solid iodine, much heat was evolved.

Gaseous hydrochloric acid was passed into the oil for some time, but on cooling the liquid no crystalline deposit separated.

A slight precipitate of silver was produced from an ammoniacal solution of the nitrate.

The value of the fruit may be estimated at about Rs. 6 per *pharrah* (about 25 lbs.).

Cumin.

Cumin or Cummin Seed* is the dried fruit of *Cuminum Cyminum* Lin., an annual, Fennel-like, umbelliferous plant, native of Upper Egypt and Ethiopia, but cultivated since ancient times in Arabia, India, China, Sicily and the countries bordering the Mediterranean. The plant ripens its fruit as far north as the south of Norway, but the bulk of the supply is derived from Sicily, Malta and Mogador. It is also cultivated in the United States. The seeds are powerfully aromatic, both odour and taste being analagous to, but hotter and far less agreeable than caraway.

The market price of Cumin is regulated by the Indian supplies. The export from India for the last few years was as follows :—

1884-5	...	...	5,860 cwts.
1885-6	...	...	7,861 ,,
1886-7	...	...	9,051 ,,
1887-8	...	...	14,110 ,,
1888-9	...	...	11,117 ,,
1889-90	...	...	11,351 ,,

* Isaiah xxviii., 25-27 ; St. Matthew xxiii., 23.

The exports from Morocco are about a tenth of those from India.

Germany is by far the largest consumer, France and Spain ranking next.

The height of the plant is about one to two feet; it is characterised by the presence of both general and partial involucres, the latter one-sided; by the calyx having five lance-shaped teeth. The fruits somewhat resemble in size and shape those of fennel, but usually have the ridges finer, more numerous, and covered with minute bristles. They also resemble the fruit of the caraway, but are larger and of lighter colour, and with nine in place of five ridges on each half of the fruit.

The yield of volatile oil is 3 per cent. from the Mogador fruit; 3·5 from the Maltese; 3 to 4 from the Syrian; and 2·25 to 3 from the East Indian. The sp. gr. at 15° C. varies from 0·890 to 0·930. Cumin oil consists of a mixture of about 44 per cent. of *Cymene* (sometimes called *Cymol, Hydride of Thymyl* and *Hydride of Cymyl*), $C_{10}H_{14}$ and 56 per cent of *Cuminol* (also called *Cuminaldehyde* and *Hydride of Cumyl*) $C_{10}H_{12}O$. These two bodies also occur in different quantities and proportions in "Roman Cumin Oil" (an exotic growth of the same plant, *Cuminum* Cyminum, Lin.); in the oil of the seeds of *Cicuta virosa* (Water Hemlock)*; in oil of *Thymus vulgaris* (common Thyme); in oil of *Thymus serpillum* (Wild Thyme); in oil of *Ptychotis ajowan* (True Bishop's Weed); in oil of *Saturcja hortensis* (Pepper-wort); and in oil of *Eucalyptus globulus.* They also occur in lesser quantity in oil of ginger, oil of nutmeg, oil of citron and oil of sage.

Cymene gives a characteristic absorption spectrum, by means of which it can be detected in essential oils. It is unalterable by contact with air, is insoluble in water, but readily soluble in alcohol, ether and essential oils.

Although more volatile then cuminol and easily separable from the crude oil of cumin by fractional distillation, it is contaminated with a small quantity of cuminol, therefore, to isolate it in purity the first portion of the distillate should be rectified over melting potash; this converts the cuminol present into cuminate of

* Ann. der Chem. und Pharm., cviii., p. 386.

potassium and allows the cymene to pass over free.* Noad obtained 7 ozs. of cymene from 1 lb. of oil of cumin. Another process of separating cymene is to agitate the oil of cumin with a moderately concentrated solution of acid sulphite of potassium or sodium, which combines with the cuminol, leaving the cymene free.

Cymene is a strongly refractive, colourless, aromatic liquid of lemon-like odour, having a sp. gr. of 0·861 at 14° C., according to Gerhardt; 0·857 at 16° C., on the authority of Noad; and, according to Kopp, 0·8678 at 12° C., and 0·8778 at 0° C. These three authorities state, respectively, the boiling point to be 175°, 171°·5 and 177°·5 C. It is now known that *pure* cymene boils at 175° C. (The earlier chemists probably operated upon impure samples).

Cymene can be obtained by mixing equal molecules of camphor and phosphorous pentoxide, heating gently until the reaction commences, when the flame must be removed, and pouring off the cymene from the meta-phosphoric acid. It is then heated once more with phosphorous pentoxide and distilled two or three times over sodium. It can also be obtained by distilling camphor with melted chloride of zinc: a few lumps of chloride of zinc are warmed in a spacious tubulated retort until they melt into a pasty mass; the camphor is then added in small portions; the mixture slightly swells up and blackens. The liquid distillate can be purified from undecomposed camphor contained in it, by rectification over chloride of zinc.

Cymene can also be prepared from oil of turpentine by adding 4 per cent. of phosphorous trichloride and passing in one molecule of chlorine for every molecule of the hydrocarbon present, the temperature being kept at 25° C., and not allowed to rise above that point. The product is then washed with water, dried, and distilled over sodium. Thus, oil of turpentine and its isomerides are converted into cymene by the loss of 2 hydrogen atoms.

It has long been known that cymene is obtainable from coal-tar,† also by treating caoutchin or oil of turpentine with bromine and sodium alternately,‡ and that by the action of moist carbonic acid

* Noad, in Phil. Mag. [3] xxxii., p. 15.

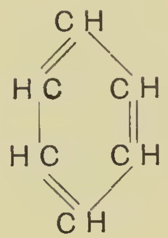
† Quarterly Journ. Chem. Soc. (1), i., p. 244.

‡ Greville Williams in Phil. Mag. [4], xxxii., p. 15.

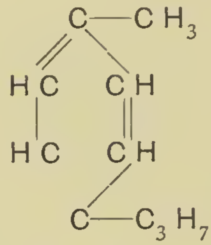
gas at a red heat on oil of turpentine, an oil is produced having the composition of cymene.*

Oil of wormseed distilled with phosphoric anhydride and then with potassium, yields an oil isomeric, if not identical with cymene.

Cymene is considered to be methyl-propyl-benzene, containing a methyl and an iso-propyl group in the para-position in a benzene nucleus, thus :—



Benzene.



Cymene.

Cymene shows the ordinary behaviour of benzene hydrocarbons towards nitric and sulphuric acids, yielding respectively nitro and sulphonic acid derivatives.

Cymene is not decomposed by caustic potash under any conditions, but chlorine and bromine attack it without the application of heat, producing chlorinated and brominated compounds decomposable on distillation. Distillation with potassium bichromate and sulphuric acid produce a violent reaction ; caustic potash being inert to the oil distilled over.

Cold concentrated sulphuric acid does not attack cymene, but fuming sulphuric acid converts it into *sulphonic acid*, which crystallises from dilute sulphuric acid in tablets containing 2 molecules of water ; this body, on fusion with caustic potash is converted into *carvacrol* (previously referred to).

Cuminol, the second named ingredient of Cumin oil, C_{10} H 2 O, formerly called *Hydride of Cumyl* also *Cuminaldehyde*, is a colourless or slightly yellow liquid having a very powerful and persistent odour of cumin and an acrid, burning taste. Its dextro-rotatory power is slightly weaker than that of cymene. It exhibits the chemical properties of an aldehyde, combining with alkaline bisulphites, and is easily transformed by oxidising agents into

* Deville, Ann. Chim. Phys. [2], lxxv., p. 66.

cuminic acid, $C_{10}H_{12}O_2$. By the action of the air or water it is also slowly oxidised into the same product.

Cuminol can be isolated from Cumin oil by fractional distillation. The retort containing the crude oil is placed in an oil bath heated to 200° C., and that temperature maintained constant until nothing more passes over. The receiver is then changed, the heat increased and the residue in the retort distilled rapidly in a current of carbonic anhydride, the distillate being collected in a flask provided with a good stopper. Another way is to agitate the crude oil with a moderately concentrated solution of potassium or sodium bisulphite. This salt combines with the cuminol only, producing a crystalline compound from which the cuminol can be separated by heating it with a little potash.

Another authority* states its preparation from Roman Cumin oil by agitating the portion which boils above 190° C, with a saturated solution of sodium bisulphite, washing the granular crystalline precipitate which has separated after 24 hours with ether, and decomposing it by distillation with sodium carbonate solution. It has been separated from the seeds of the "Water Hemlock" by a similar process.†‡ Cuminol boils at 236°·5 C. Its sp. gr. is 0·9727 at 13°·4 C. Its mean composition on analysis is 80·89 per cent. C; 8·85 per cent. H; and 10·66 per cent. O. The formula $C_{10}H_{12}O$ requiring 81·08 C, 8·11 H, and 10·81 O. It is now usually expressed as follows:—$(CH_3)_2CH, C_6H_4, CHO$.

Cymyl alcohol, or *Cumin alcohol* $(CH_3)_2CH, C_6H_4, CH_2OH$, was first obtained by Kraut§ by the action of alcoholic potash on cuminol (cuminaldehyde). It is an oily, faintly aromatic smelling liquid, of burning taste, and boiling at 246°·6 C. Sp. gr. 0·9775 at 15° C.

Cymyl chloride, $(CH_3)_2CH, C_6H_4, CH_2Cl$, is formed by the action of hydrochloric acid on cymyl alcohol, and is a liquid which boils at 230° C.‖

Cymyl acetate, $C_3H_7 C_6H_4 CH_2 OC_2H_3O$, is prepared by heating the impure Cymyl chloride with potassium acetate. It is

* Ann. Chem. Pharm., xcii. p. 66.

† Ibid, cviii., p. 386, and xciv., p. 317; Ber. Deutsch. Chem., Ges., x., p. 150.

‡ The yield of essential oil from the seeds of Water Hemlock *(Cicuta virosa)* is about 1½ per cent.

§ Ann. Chem. Pharm., xcii., p. 66; cxcii., p. 224.

‖ Gaz. Chim. Ital., ix., p. 307.

a liquid which boils at 236° C. and has an odour like *rose-wood oil.**

Thyme.

Wild Thyme, *Thymus Serpyllum*, Linn. The Thyme genus, of which the well-known Wild Thyme of our banks and dry pastures is a familiar example, belongs to the Labiatæ, and is widely distributed over Europe, Nothern Africa and Central Asia, but is must abundant in the Mediterranean region. Between forty and fifty species of it are described, all low, much-branched, spreading or decumbent shrubby herbs, and having small, entire leaves, often with their edges turned in, and dense terminal leafy heads or loose spikes of purple or rarely white flowers.

T. Serpillum has procumbent stems and numerous, short, ascending branches, ending in short, loose, leafy, whorled flower-spikes; the leaves being egg-shaped and narrow, and more or less fringed towards the bottom, those of the flower-spikes being similar but smaller. There are two forms—*T. en-Serpillum,* with flowering branches ascending from shoots, which are barren at the tip, in one head, and the upper lip of the corolla oblong, and *T. Chamædrys,* in which all the branches ascend from the crown of the rootstock, with whorls in many axillary-heads, and a short and broad upper lip to the corolla.

Common or **Garden Thyme**, *T. vulgaris,* grows more erect than the Wild Thyme, is clothed with hoary down, and has the edges of its leaves turned in; its flower-whorls are in loose terminal heads, or some of the lower ones are remote from the others; the leaves of the whorls are blunt, while the ordinary ones are sharp-pointed. It is a native of Spain and Italy, in dry, arid, uncultivated places, and grows largely in the South of France. It is recorded as having been introduced into this country about A.D. 1548.

Lemon-scented Thyme is a hardy, very dwarf trailing evergeen, possessing the most agreeable perfume of any of its genus, and which has been long cultivated in this country. It is a variety of *T. Serpyllum* known as var. *citratus* or *citriodrus.* It is very distinct in appearance from the wild form. There is a

* Ber. Deutch. Chem. Ges., iii., p. 480.

variety of it with golden edged leaves, which is frequently grown for ornamental purposes, but unless frequently renewed by cuttings it has a tendency to lose the yellow coloration. The branches of lemon-thyme, both plain and variegated, trail on the ground and root at the joints, consequently its cultivation is of the easiest. It is found to obtain the greatest perfection when grown on a light, dry, sandy soil in an exposed situation, especially on a slope. It is thought that plants of lemon-thyme raised from seeds have not so agreeable a perfume as those raised from cuttings or division of the plant.

For propagation by seed, sow in March or April in a bed or border of light fine earth, either broadcast, scattered thin and raked in lightly, which is the general course, or in small shallow drills, six inches asunder; the young plants may either remain, or be transplanted in the summer when 2 or 3 inches high. As soon as the plants are 3 or 5 inches in growth, in June or July, taking the opportunity of rain, thin them out, and plant six inches asunder, and water at planting; or they may be planted 10 or 12 inches apart, as they soon spread to bushy plants.

Thyme is also propagated by slips of the branching shoots in the Spring or early in Autumn, but more especially by sections of the bush or by removing rooted branches. Plant all these in light rich earth and shade and water well till rooted. The harvest is cropped in August, by cutting the plants rather closely down with a very small sickle, holding the top of the plant with the left hand. Seed is produced abundantly in this country and ripens in Summer and Autumn. The seed spikes should be dried on a cloth, rubbed out clean and preserved in a dry place for sowing the following year. In using the herb for distillation it should not be dried, but the crop gathered each day put into the still at once.

In the South of France, and especially at Nimes, thyme is largely cultivated for its essential oil. Two harvests are there taken in the year, the first in May and June, when the plant is in flower, and the other in Autumn. The crude oil of thyme is of a reddish-brown colour; rectification decolourises it, but renders it less fragrant. These two sorts of oil are known commercially as "Red" and "White oil of Thyme." In England oil of thyme is frequently called "Oil of Origanum." Oil of the golden-edged lemon-thyme, distilled by the writer, was of very pale yellow

colour, and had a combined odour of thyme, lemon and geranium. By fractional distillation, oil of thyme is separated into two parts: the first, boiling at 178°-180° C., being a mixture of *Cymene* $C_{10}H_{14}$ and *Thymene* $C_{10}H_{16}$; and the second portion boiling at 230° C., *Thymol*, $C_{10}H_{14}O$.

The medicinal and powerfully antiseptic properties of Thymol have enhanced the value of oil of thyme. The value of oil of thyme is therefore dependent on the percentage of thymol present in the sample.*

Thymol is also abundantly contained in the essential oil of the seeds of Ajowan *(Ptychotis Coptica)*, a plant largely cultivated in India. Immense quantities of this seed are sent to Germany, where it is distilled. Thymol may be separated from either of these essential oils (of which it is the oxygenated constituent), by treatment with caustic potash or soda as described below, or by submitting the essential oils to a low temperature for some days. When prepared by the first process, thymol occurs as an oily fluid, and when by the second, as a crystalline solid. The following are the details of the preparation of the liquid variety of thymol as given by the Paris Pharmaceutical Society:—"Treat essential oil of thyme with an equal volume of an aqueous solution of potash or soda, and shake several times to facilitate combination. The thymol dissolves, forming a soluble compound, whilst the *thymene*, a hydrocarbon that accompanies it it in the oil, does not combine with the alkali, and separates. Filter the solution obtained, and treat with an acid,—hydrochloric acid for example—which sets free the thymol. The product should be purified by washing, dried and distilled."

Thymol was obtained in fine tabular crystals by Flückiger and Hanbury, who exposed the oil of ajowan to a temperature of 0° C.; the oil so treated yielded 35 per cent. of its weight of crystallised thymol. It is stated that oil of thyme yields as much as 50 per cent.

As found in commerce, thymol consists of irregular broken crystals, or thin colourless rhombic scales, nearly transparent. The taste is burning and aromatic. Sp. gr., 1·028, but lighter than water when fused. It is optically inactive. It melts between 50°

* For the efficacy of thymol in diphtheria, see Pharm. Zeit., 1890, p. 261, and in chyluria, Lancet, 16th Feb., 1891.

and 52° C. to a colourless liquid. When once completely fused and allowed to cool to the ordinary temperature, it will maintain itself in the fluid condition for several days, but the contact of a crystal will at once cause it to crystallise. Its boiling point is near 230° C. It dissolves sparingly in water, requiring at 15° C., 1100 to 1200 parts for solution; but is soluble in half its weight of alcohol, ether or chloroform, in 2 parts of soda solution, sp. gr., 1·16, and freely in benzene, carbon disulphide, glacial acetic acid and fixed and volatile oils. Ammonia dissolves it but sparingly. The potash and soda solutions are spoken of by some authors as chemical combinations, but the following test will demonstrate them otherwise:—When shaken with ether, the thymol can be entirely removed and obtained as a neutral volatile residue.

When thymol is triturated with one half to ten times its weight of camphor, a colourless, syrupy liquid is obtained. According to Gerrard, the strongest aqueous solution of thymol possible, is 1 in 1,000, and a solution of 4 grains of it in a fluid ounce of alcohol is miscible with water without becoming turbid; 3 grains of thymol are dissolved by 1 grain of caustic soda and 1¼ grain of caustic potash. Solid fats, when heated, are excellent solvents of thymol. A solution of 1 part of thymol in 100 parts of warm glycerin remains clear. Thymol is also soluble in 4 parts of cold sulphuric acid, the solution has a yellowish colour, and on being gently heated, becomes rose-red. On pouring this solution into 10 volumes of water, digesting the mixture with an excess of lead carbonate, and filtering, the liquid becomes violet-blue on the addition of ferric chloride. This reaction is due to sulphothymolic acid, $C_{10}H_{14}SO_4$. Hammarsten and Robert gave the following as the most delicate test by which one millionth of thymol may be detected:—Mix the liquid with one half of its volume of glacial acetic acid, then with at least an equal volume of sulphuric acid, and warm gently, when a bright reddish-violet colour is produced which is not destroyed by boiling.

Gerrard states that in operating upon nine different samples of commercial oil of thyme (so-called oil of Origanum), by means both of caustic soda and refrigeration, he was unable, except in one doubtful case, to obtain the slightest trace of thymol, the inference being that commercial oil of thyme does not contain thymol, that body having been removed from it previous to putting it on the

market—the residual thymene and cymene being passed off as "Oil of Thyme." These last mentioned constituents have a very different odour to genuine oil of thyme, and are unsuitable to the perfume manufacturer, except for employment in very common soaps.

Undiluted thymol is an energetic caustic. According to Bucholz, thymol possesses ten times the septic power of carbolic acid, over which it also has the advantage of being non-poisonous, and of giving off an agreeable odour.

One of the known sources of Thymol is the essential oil of *Monarda punctata*, which see.

The *Thymus serpyllum*, found on the temperate Western Himalaya (the seeds of which are used medicinally in the Punjab), is of comparatively little value, as its oil contains but a small proportion of thymol.

Thymol is also known chemically as *Metacymophenol*, $C_3H_7, C_6H_3(OH)CH_3$.

On distillation with phosphorus pentasulphide, it yields cymene, and is decomposed into metacresol and propylene by heating with phosphorus pentoxide.* As a phenol it forms salts, ethers and ethereal salts, such as:—

Thymyl methyl ether, $C_{10}H_{13}OCH_3$. Boiling at 216°·7 C.†
Thymyl ethyl ether, $C_{10}H_{13}OC_2H_5$. Boiling at 222°.‡
Thymyl acetate, $C_{10}H_{13}OC_2H_2O$. Boiling at 244°·7.
Thymyl benzoate, $C_{10}H_{13}OC_7H_5O$. Melting at 32°.§

Zataria multiflora, Boiss. A small labiate herbaceous plant found on the hills near Muscat, in Arabia. The dried plant is much used in India in infusion as an agreeable aromatic stimulant, and is sold in the Bazars under the name of Saatar. It has a fragrant odour like lemon-thyme, and consists of small ovate, or nearly round, dotted, entire, rather leathery leaves, the largest of which are about ¼ of an inch long; mixed with them are portions of a slender woody stem and numerous minute flowers, forming knotted clusters upon a slender spike; each flower is furnished

* Zeitschr. Chem., 1869, p. 621.
† Bull. Soc. Chim., xxv., p. 32.
‡ Zeitschr. Chem., 1865, p. 532.
§ Journ. Prakt. Chem. [2], xxxvi., p. 7.

with a small bracte, and, when magnified, the bractes and calyces are seen to be densely covered with jointed hairs. The calyx is unequally 4-cleft, the corolla labiate, and of a red colour; the calyx and flower, after being soaked in water for 24 hours, only measured $\frac{1}{8}$ of an inch in length. The leaves, when magnified, present a mossy surface, which is thickly pitted, each pit containing a granule of red, resinified essential oil.*

Ziziphora tenuior, Linn. This plant is a native of Persia and Beluchistan, and is sold in the Indian Bazars under the name of Mishk-i-taramashia. The Mahomedans of the East identify this plant with the ζυγις, or "Wild Thyme," of the Greeks. In Shiraz it is called Rang.

Aitchison states that the peasants in the Harirud Valley and Khorasan call the plant Kakuti. As described by Dr. Dymock† and others, it is a small herbaceous plant resembling Thyme, two or three inches high; the root is about the same length, woody, single, with a few small fibres. The stems, which are 2 to 5 in number, are square, and are also woody, and branch from the ground; they are thickly studded with leaves and lateral flowers, which reach to the apex, and form a spike. The leaves are opposite, linear-lanceolate, and have several prominent, straight veins on each side of the midrib. The calyx is purple and striated with 13 nerves, throat bearded; corolla 2-lipped, the upper lip reflexed, the lower one trifid and spreading. The seeds are four in number, oblong, brown in colour. The odour and taste of the plant is very pleasant, *like peppermint, but sweeter.* The plant is figured in Lamarck's "Illustration des genres," t. 18, f. 2; the Spanish species, *Z. hispanica,* being shewn on the same plate, f. 1.

Z. serpyllacea, the "Sweet-scented Ziziphora," native of the Caucasus, is figured in Bot. Mag. t. 906.

Thymus piperella, Lin. Syst., p. 452, the "Small Peppermint Thyme," is a native of the region of the Mediterranean, as Barbary, Spain, Mount Parnassus, &c. It is a small procumbent suffruticose shrub, with ascending, stiff, pubescent branches. The leaves are petiolate, broad-ovate, obtuse, truncatety subcordate at the base, not ciliated, thick, stiff, veiny, glandular; the floral ones

* Pharmacographia Indica, iii., p. 115.

† Ibid., iii., p. 115.

conforming to the others; calyx almost glabrous; teeth of upper lip short, ovate, and the segments of the lower lip subulate, ciliated. Syn. *T. graveolens*, Sibthorp and Smith, Floræ græcæ prodromus, vi., p. 61, t. 576.

Ajowan.

This small umbelliferous annual herb, commonly known as "True Bishop's Weed," is the *Ptychotis Ajowan* of D. C.; *Ammi Copticum*, Lin.; and *Ligusticum Ajowan*, Roxb. Flor. Ind., ii., p. 91; Boissier Flor. Orient., ii., p. 891; Lindley Flor. Med., p. 36; Wight Icones Flor. Ind. Orient., t. 566; Bentley & Trimen Med. Plant. t. 120; Pharmacographia, p. 271; Pharm. Journ. [1], xiv., p. 272, also [3] i., p. 1,007 with figure of the seed.

The oriental vernacular names, collected and verified by Modeen Sheriff are:—

Arabic	Kamúne-muluki
Persian	Nankhah and Zinyan
Hindustani	Ajvayan
Dukhni	Ajvan
Tamul......................	Omam
Telegu	Omamu or Vamamu
Malayalim	Ayamodakam and Homam
Canarese..................	Voma
Bengali	Ajvain or Ajvan
Mahratta	Vova-sada and Vova
Gujerati	Ajwan
Cinghalese	Assamodagun or Omam
Burmese..................	Samhum

This plant is cultivated in many parts of Egypt, Persia, Afghanistan and abundantly in Bengal. Botanically it is thus described:—Stem erect, dichotomous; leaves few, cut into numerous linear or filiform segments, the uppermost simply pinnate; umbel with 7-9 rays; involucre few-leaved; leaflets linear, entire, fruit strongly ribbed, covered with small blunt tubercles (which are especially evident on examination by a lens), by which and by their thyme-like odour they may be distinguished from the seeds of *Apium graveolens*, *A. involucratum* and *A. petroselinum*, which in shape they much resemble, although they are smaller than caraways or any umbelliferous fruits imported into Europe. The fruits vary in size from $\frac{1}{16}$th to $\frac{1}{10}$th

of an inch in length; in colour they are greyish brown, the largest much resembling those of common parsley, but they are readily distinguished from them by their rough surface and strong odour of *Thymus vulgaris* when rubbed.

Under the name of *Semen Ammi*, the small fruit of *Ammi majus* Lin. and of *Sison Amomum* Lin. have sometimes been mistaken for, or substituted for those of true Ajowan, but they can be easily recognised by the absence of small tubercles on their surface.

In India the seeds of *Hyoscyamus niger* Lin. are called *Khorasani ajwan*, but a very superficial examination is sufficient to recognise them.

The fruits of Ajowan yield rather over 3 per cent. of an agreeably aromatic volatile oil of sp. gr. varying from 0·900 to 0·930 at 15° C. A crystalline substance, $C_{10}H_{14}O$, identical with Thymol, also distils over. The oil, after being rectified over calcium chloride, yields, on being exposed to a temperature of 0° C., about 40 to 50 per cent. of this body. The fruits are distilled to an enormous extent in Germany for the purpose of extracting it. It is obtained in India by exposing the oil to spontaneous evaporation, and sold in the Bazars of the Deccan under the name of Ajwain-Ka-phul, or "Flowers of Ajwain" (see Thymol). According to Flückiger the sp. gr. of this thymol is 1·028, it is optically inactive; its melting point in small quantities is 44° C. and in bulk 51° C. He observes that on again refrigerating it, it remains in a liquid state for a considerable time, or until a crystal of thymol is thrown into it. (Respecting an error in the determination of congelation points of such bodies, see the remarks on Anethol.

The odour of the liquid constituent of oil of Ajowan is different to that of the thymol. Its boiling point is 172° C. It is considered to be an isomer of cymene $C_{10}H_{14}$ (which see), and is optically inactive. The crude oil also probably contains a small quantity of the hydrocarbon $C_{10}H_{16}$.

The medicinal uses of Ajwan are described in the Bengal Pharmacopœia and in the Pharmacopœia of India. The distilled water appears to be particularly useful in cases of cholera. The seeds themselves are much valued as a pungent aromatic for culinary purposes, in fact in India this plant is considered one of the most useful of the umbelliferous tribe.

Basil.

Ocimum basilicum, Linn. Sweet Basil. Wight Ic. t. 868; Jacq. Hort. Vind., iii., t. 72; Rheede Hort. Mal., x., t. 87. A native of the East Indies and tropical Africa. It is rather a tender annual and highly aromatic. The parts used are the leaves and small branches or leafy tops. Three forms of this labiate plant are common in India: the mint-like garden basil, with large flowers and green or purple stems; the variety *pilosum* of Roxburgh having a pleasant lemon odour, and a small variety common in gardens and on waste ground, having a marked peppermint odour, hardly different from *O. canum*.*

Roxburgh states the *O. basilicum* to be a native of Persia, and was from thence sent to the Botanic Garden at Calcutta under the Persian names Deban-shah and Deban-macwassi. It is very nearly allied to *O. thyrsiflorum*. It is an annual; the whole plant has somewhat a ferruginous appearance. Leaves ovate-oblong, grossly and acutely serrate, smooth. Bractes lanceolate, ciliate. Upper lip of the calyx broad-cordate. Stamen and style longer than the corolla. Filaments amply crested. In Bengal it flowers during the rains and cool season. The leaves distilled with water yield about 1·56 per cent. of a yellowish-green oil, lighter than water† which, when kept, solidifies almost wholly, as crystallised *Basil camphor;* the solid oil crystallised from alcohol forms 4-sided prisms, having a faint smell and taste; crystallised from water, it forms white, transparent, nearly tasteless tetrahedrons.‡

Basilicum oils of very fine quality are distilled in Java and in the island of Réunion. The excellent fragrance of these oils renders them very suitable for blending in compound bouquet perfumes, and they are said to have a specially excellent effect in the composition of "Mignonette extract."

The History of Basil in Europe is described by De Gubernatis, "Mythologie des Plantes," ii. p. 35. Mention of its medicinal properties is made in "Medical Record," xvi., p. 325. The price of the seeds in Bombay is quoted by Dr. Dymock as Rs. 4 per maund of

* Pharmacographia Indica, iii., p. 85.

† Journ. de Pharm., xx., p. 447.

‡ Gmelins Handbook, xiv., p. 359.

$37\frac{1}{2}$ lbs. The vernacular names of *O. basilicum* (as given in Pharmacographia Indica) are, Názbo, Sabza (Hind.); Sabja (Mar., Guz.); Násbo, Sabja, Baboi-tulsi (Beng.); Tirunitru-pachchai (Tam.); Vibudi-pattri (Tel.); Kam-Kasturi (Can.).

Ocimum pilosum above referred to is an erect shrubby plant, native of India; known in Bengal as Babooi-tulsi. The stem and branches are 4-sided and furrowed; leaves ovate-oblong, serrate; bractes petioled, sub-orbicular, hairy; under lip of the calyx orbicular and hairy, with corolla twice its length. This is the *Basilicum Indicum* of Rumphius, Amb., v., p. 263, t. 92, f. 1. See also Roxburgh Hort. Beng., p. 45.

Ocimum caryopyllatum, known in the Hindustanee and Bengalee as Gulal-tulasi, is a shrubby plant with erect stem and opposite branches nearly round, polished, leaves broad lanceolar, serrulate, smooth. It is in blossom most part of the year, but chiefly during the latter part of the rainy and in the cold season.

Ocimum thyrsiflorum, Linn., Mantissæ plantarum p. 84. Murray, Commentarii Gœtingensis, viii., p. 47, t. 5. Jacqmin, Hortus botanicus, iii., t. 72. This plant, which has been considered by some botanists to be the true Sweet Basil, is described by Roxburgh* as one of the most fragrant species of ocimum in India, it was introduced by him into Bengal from Madras and successfully propagated from seed. It flowers chiefly during the rainy or cool season and the seed ripens in the dry season. It is a biennial, erect shrub of about 3 feet in height, with many opposite, spreading, 4-sided branches, the sides being deeply grooved. Leaves petioled, opposite, broad lanceolate; on the interior margins of the largest are 2 or 3 remote serratures, sharp-pointed; panicles, a terminal, ovate, dense one to each branch, ramifications thereof decussate. Flowers large, pale pink, forming a pretty contrast with the ferruginous calyces and bractes. Bractes opposite, lanceolate, ciliate, 3-flowered, of a deep ferruginous colour. Calyx, upper lip orbicular and ciliate, and its upper surface of the same colour as the bractes; under-lip 4-cleft. Corolla, under lip broad, 4-parted, the under one of the same length, linear-oblong, with a rounded crenate apex. Filaments, the superior short pair amply crested.

* Flor. Ind., iii., p. 158.

Ocimum bullatum, Lam., Ency., i., p. 384, is not considered by Roxburgh to be a native of India, as it is found in gardens only and the natives have no vernacular name for it. He states that its scent is very powerful, more so than that of any other species he has met with.

Ocimum minimum or "Least Basil" is a very aromatic plant, a diminutive form of *O. basilicum* and closely allied to O. Forskelii.* It is an erect plant with herbaceous stem, forming a round bushy head, all parts finely pubescent; leaves, which are hardly larger than those of Thymus serpyllum, are on long petioles, ovate, almost quite entire, glabrous; floral leaves almost like the others; raceme simple, short; whorls loose; calices rather shorter than the pedicles, reflexed in the fructiferous state, upper tooth orbicular; lower ones short, acute. It is a native of Chili, near Valparaiso.† Syn. *O. salinum* Molina.‡ This plant is only from 6 to 12 inches in height.

Ocimum gratissimum Lin. Jacq. Ic. Pl. Rar., iii., t. 495; Rheede (under name of Cattu Tirtava), Hort. Mal., x., t. 86. A native of Bengal, Chittagong, E. Nepal and the Deccan Peninsular.

This plant is the Varvara, Barbara and Ajvalla of the Nighantás. The vernacular name in Hindustanee and Bengalee is Ram-tulasi.§ The leaves have a remarkably grateful lemon odour and taste. The seeds imported into Bombay from Persia under the same names (and used medicinally) bear no resemblance to those of *O. gratissimum.* Roxburgh says‖: The whole plant diffuses a stronger degree of fragrance than any other of the genus. It is only found in gardens and about the Temples of the natives. Stem erect, woody, perennial. Bark, ash-coloured. Branches opposite, erect, 4-sided, when young, smooth glossy and green; height of the plant from 4 feet to 8 feet. Leaves opposite long-petioled, drooping, oblong, ventricose, remotely serrate, smooth on both sides, often 6 inches long including the petiole, which is about a third of the whole. Racemes terminal,

* Benth. Lab., p. 6.

† Schkuhr, Botanisches handbüch, ii., t. 166.

‡ Saggio sulla storia naturale del Chili, p. 291.

§ Pharmacographia Indica, iii., p. 85.

‖ Flora Indica, iii., p. 17.

pretty long, rigidly erect, with the verticels of 6 flowers. Bractes short-petioled, reflexed, cordate-lanceolate. Calyx, upper lip marked with 3 nerves. Corolla short, scarcely larger than the calyx, of a pale yellow underneath, oblong, concave and entire. Filaments longer than the corolla, with a large tuft of dark yellow hairs on the joints of the large pair near the base. By some this plant has been considered identical with the *Ocimum Zeylanicum* of Burmann, Thesaurus Zeylanicus, p. 174, t. 80, f. i., and with *Ocimum petiolare*, Lam. Dic., i., p. 385.

Ocimum sanctum Linn. Burm. Thes. Zeyl., 174, t. 80, ff. 1 and 2; *Basilicum agreste* Rumph. Herb. Amb., v., p. 265, t. 92, f. 2. This plant is found throughout India in dry places and is commonly known as Tulsi and Tulasi. In English it is known as Holy Basil. It is botanically described as a short-stemmed woody perennial; branches numerous, opposite, round, usually dark purple, hairy; leaves opposite, petioled, oval, serrate, downy, about $1\frac{1}{2}$ inches long and 1 inch broad; racemes terminal, erect, usually dark purple, hairy, 4-sided; bractes opposite, petioled, cordate, reflex, 3-flowered; seeds black, oblong, about $\frac{1}{10}$ of an inch long, slightly arched on one side and flattened on the other, blunt-pointed. The seeds are used medicinally. The Tulasi plant is venerated in India by the Hindus like the Vervain was amongst the Romans. Its worship is expounded in *Tulasikavaçam,* a little book composed of two parts: the first being the Tulasikavaçam proper, or "Tulasi amulet," and the second a hymn in honour of the plant. Interesting particulars respecting the worship of the Tulasi plant and its medicinal virtues are given in the Pharmacographia Indica, iii. p. 87. Sanskrit writers make two varieties of this plant, founded upon some difference in the colour of their leaves, viz., white and black, but the plant, irrespective of colour, is called in Sanskrit Tulasi and Parnasa.

Ocimum villosum Roxb. (Syn. *O. Basilicum var. anisatum,* Benth.). The Hindustanee and Bengalee name Tulasi is also applied to this plant, but it differs in many respects to the true Tulasi. Its Sanskrit name is Urjuka.* It is the Soladitirtava of Rheede† and the *Basilicum citratum* of Rumphius‡ describes it as follows:—

* Asiatic Researches, iv., pp. 288-9.

† Hort. Mal., x., p. 173, t. 87.

‡ Amb., v., p. 266, t. 93, f. 1. Roxburgh (Flor. Ind., iii.).

This charming species is common in gardens, and about the Temples of the Hindus, over every part of India. It is in blossom most part of the year. It has a short, erect, woody, round stem. The bark has a thin, light-brown, scaly epidermis. Branches numerous. The tender shoots clothed with much soft white hair. The general height of the whole plant is from 2 to 3 feet. Leaves opposite, petioled, ovate, oblong, crenate serrate, obtuse, downy, from 1 to 2 inches long. Petioles half the length of the leaves, downy. Racemes, terminal, solitary or triple. Flowers triple and opposite, appearing verticelled; of a pale greenish pink. Bractes opposite, petioled, reniform, cordate, acute.

Ocimum canum is very nearly allied to *O. Basilicum*, but the flowers are not half the size, and the habit distinct. It is herbaceous, erect, about one foot in height, pubescent. Its leaves are petiolate, ovate, narrowed at both ends, almost quite entire, canescent beneath; petioles ciliated; racemes simple; calyces longer than the pedicels, reflexed in the fructiferous state; upper tooth of calyx orbicular, concave, shortly acuminated; corollas white. The whole plant very aromatic. It is a native of Madagascar, East Indies, China and Brazil. It is figured in the Bot. Mag., t. 2452.

Ocimum crispum, Thunb. Flor. Jap., p. 248, is another fragrant species. It is a native of Japan, about Nagasaki. Its stem is tetragonal, villous, branched. Leaves ovate-acuminate, serrate, curled, petiolate, glabrous, purplish, an inch long; calices hispid. A decoction of this species is used in Japan to give a deep red colour to radishes, turnips and various vegetables. The various species of *Ocimum* are in all cases destitute of any deleterious secretions, and are for the most part fragrant and aromatic.

Other species of less importance (possessing little or no fragrance) are *Ocimum album* (Willd., iii., p. 160); *Ocimum polystachion* (Willd., i., p. 365), and *Ocymum tuberosum*, known as Neeru, or "Water tulasi," it growing in ditches and wet places, and *Ocimum tuberosum*,* a small perennial about a foot in height, native of valleys among the Orissa mountains. *Ocimum cristatum* and *Ocimum inodorum* are entirely destitute of fragrance.

All the above species are of easy culture and propagation. The

* Rox. 6, Fl. Ind., iii., p. 18.

shrubby and perennial kinds are readily increased by cuttings. The seeds of annual kinds should be reared in a hot-bed and afterwards planted out.

Anise and Star Anise.

The fruit of *Pimpinella Anisum*, Lin., is known as "Aniseed"; "Alicante Aniseed," "German Aniseed," and "Russian Aniseed." The Alicante variety is the best.* The umbelliferous plant producing it is indigenous to Asia Minor and Egypt and is cultivated in Spain, Malta, Greece, Southern Russia, Chili, India, and such parts of Europe where the climate is sufficiently warm to mature the fruit, but not in England. It is a low annual with many of the usual characters of the order, and has cordate, divided radical leaves and biternate cauline leaves. The umbels are many-rayed and have no involucres. The fruits have generally entire cremocarps about 2-tenths of an inch long, on slender pedicels, and crowned by a pair of short styles. The fruit is ovoid, greenish brown, and has 10 pale-coloured ridges, giving it a prismatic appearance; all the surface is covered with minute hairs.

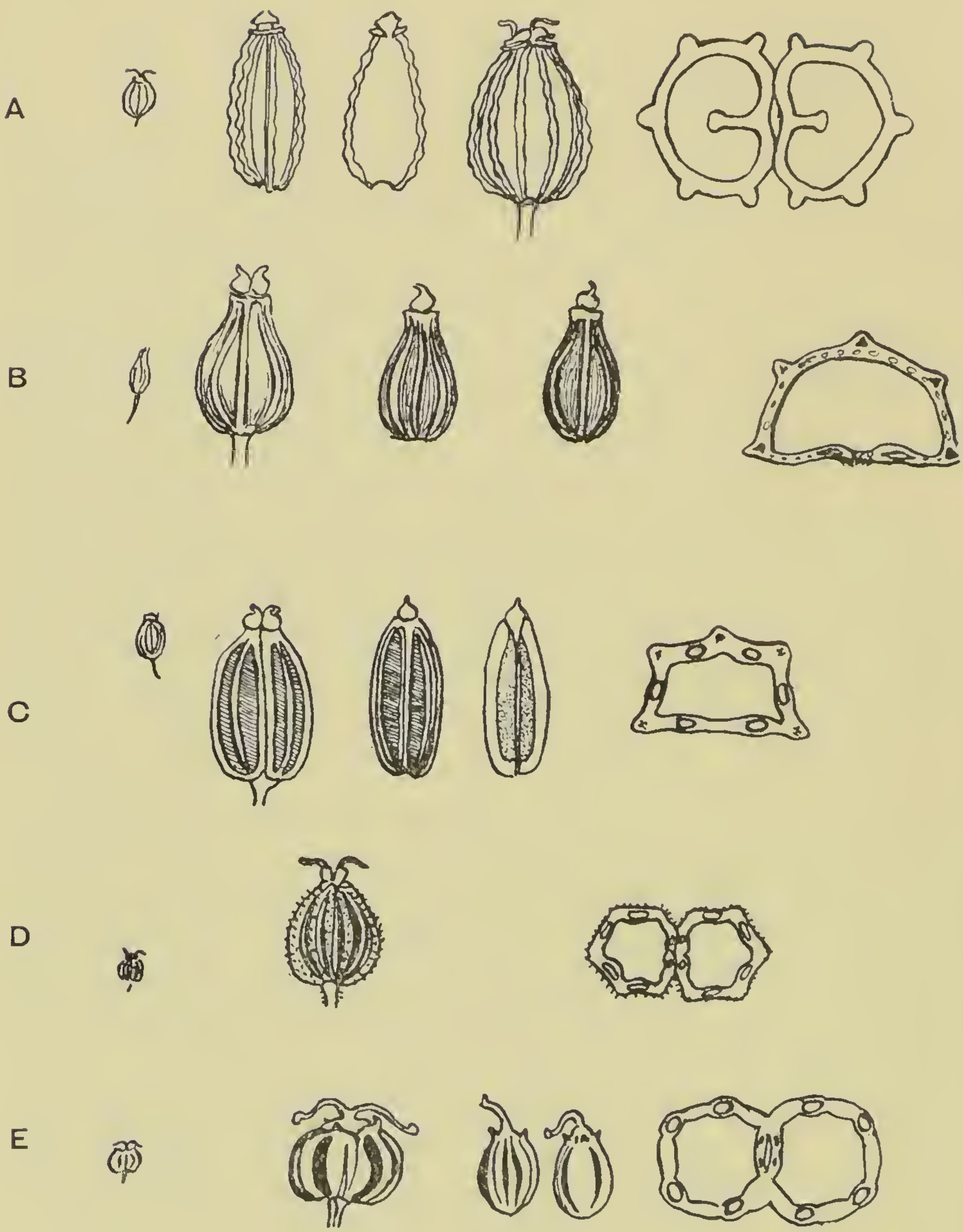
The Russian fruits are smaller than those of the other varieties and have some resemblance to Hemlock fruits (*conium maculatum*), with which they sometimes get mixed by mistake; the two should therefore be compared. The anise is readily distinguished by the ridges not being wavy, by having an abundance of vittæ, by their hairy surface, agreeable aromatic odour, united mericarps and persistent pedicel. (*Conia*, the volatile poisonous alkaloid contained in hemlock has an odour resembling that of mice.)

A sample of aniseed recently examined by an analyst in Holland was found to contain 2½ per cent. of seeds of *Conium maculatum*, 55 per cent. of fennel seed, and 10½ per cent. of the seeds of a grass (*Panicum*). Consequently this lot of aniseed was declared unsafe for use, was seized by the authorities and destroyed.† Weynton, in a Paper on "The Commercial products of Siam," read before the East India Association on the 7th April, 1887, says:—

* Pereira, Mat., Med., ii. pt., ii. p., 162; Pharmacographia, p. 277. Bentley and Trimen Med. plant. t. 122. Woodville, Med. Bot. t. 52. Stevenson and Churchill Med. Bot. t. 156.

† British and Colonial Druggist, xxii., p. 275.

EXAMINATION OF VARIOUS FRUITS.



Natural size of entire fruit; magnified appearance of the same; of the dorsal surface of the mericarp; the commisural surface of the mericarp; and of the transverse section.

A.—*Conium maculatum.*

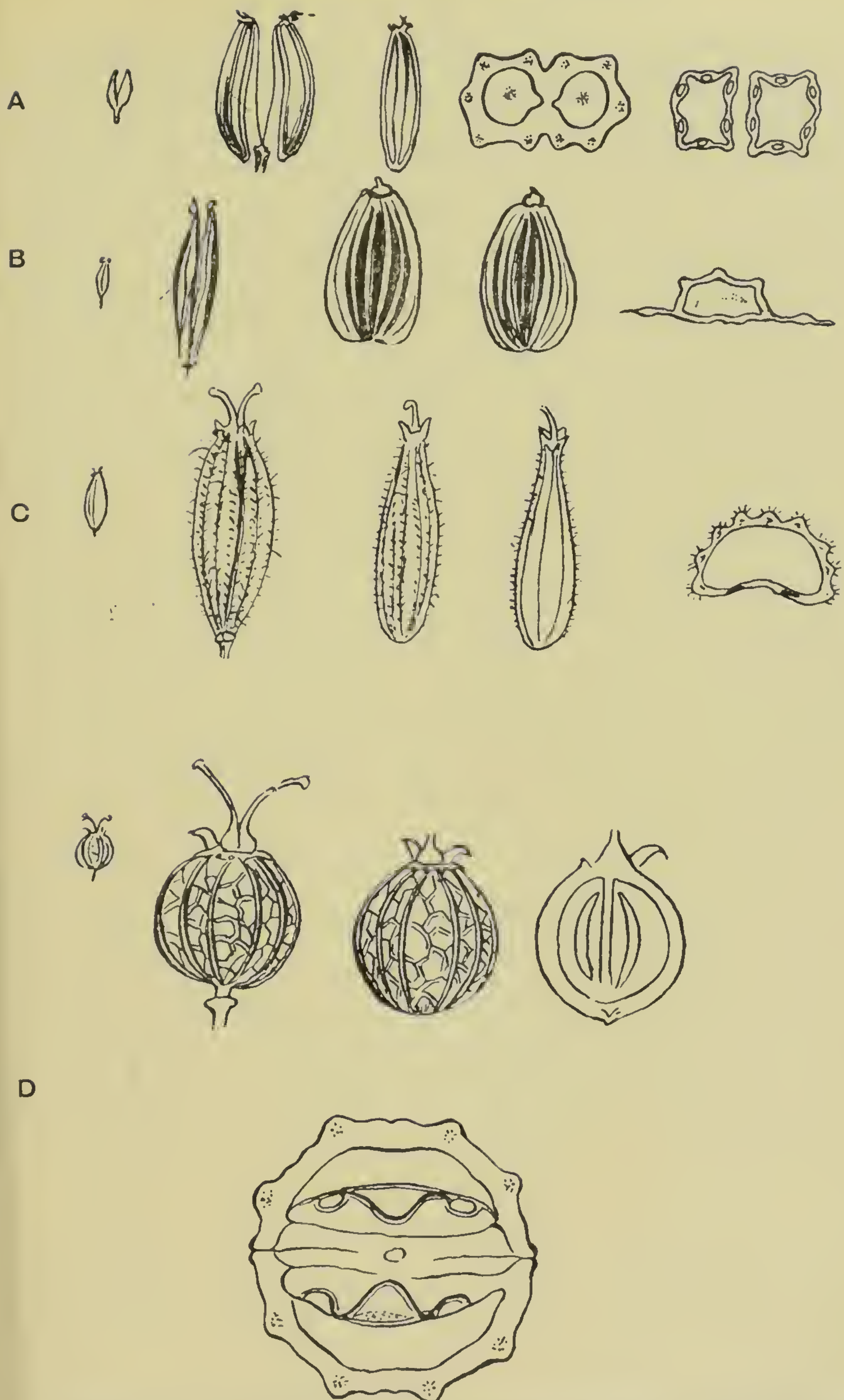
B.—*Pimpinella Anisum.*

C.—*Fœniculum capillaceum.*

D.—*Carum Ajowan.*

E.—*Cicuta virosa.*

EXAMINATION OF VARIOUS FRUITS.



Natural size of entire fruit ; magnified appearance of the same ; of the dorsal surface of the mericarp ; the commisural surface of the mericarp ; and of the transverse section.

A.—*Carum Carvi.*

B.—*Peucedanum graveolens, Benth.* (Dill).

C.—*Cuminum cyminum.*

D.—*Coriandrum sativum.*

"Aniseed and Star anise are both to be found in abundance in Assam, the first under the name 'Mahori,' the latter under that of 'Badian.' Among the low hills round about Jowhatti, on the old road to Cherraponjee, and in the Terai forest of both sides of the Khassia and Naga hills, sufficient seedlings of aniseed for stocking an acre can be easily procured, but considerable care is required in transplanting them, and this should be done during the cold weather, the plants lifted with as much earth round the roots as can conveniently be carried." As in this locality it is customary to distil an oil from the *leaves* of the aniseed plant, the writer says:—"The object being to obtain as luxuriant a foliage as possible, high cultivation and copious manuring should be resorted to; the plant may be put in 4 feet by 4, the same distance as tea is planted, but if that part of the district in which the grant is situated is more than ordinarily subject to visitations of blight and red spider, it will be prudent to plant somewhat wider, say 5 by 5, for though tea leaves afflicted with the two pests mentioned make but little difference in the turn-out, the quality of the oil of aniseed will be very sensibly affected by the presence of unhealthy leaves, hence the aniseed plantation must be kept clean and in good order. To get the largest yield from the plant, pruning with that view may be carried out as with tea. The leaves should be gathered precisely as with tea, but removed from the plucking baskets more often, for no heating must be permitted, and plucking should only take place in dry weather. . . . . As regards the Star anise, the object being to obtain the largest amount of fruit, the plant will require that class of manure which contains the greatest amount of phosphates. Hence pulverised bones, phosphate, animal or fish offal will be best for it. Although the chief dependence should be placed on the fruit, the *bark* is almost equally rich in oil."

Anise does not appear to have been known to the ancient Hindus and is not mentioned in Sanskrit works. It was introduced into India by the Mahometans from Persia, whence the supply for the Bombay market still comes. Dr. Dymock says* the natives use anise in the same way as we do. The Persians call it Báziánah, which the Arabs corrupt into Razianaj. They identify it with the Anisum of the Greeks, and the Mahometan druggists of India

* Pharmacographia Indica, ii., p. 132.

know it by this name. The Bombay name "Ervados" is a corruption of the Portuguese "Herba doce." Modeen Sheriff states that the seeds of *Carum Roxburgianum* are sold in Southern India as Anisum.

Anise is now grown in Northern India. As met with on the market, Dr. Dymock says the fruit varies a good deal in size; if well grown it should be about 2-tenths of an inch long. The mericarps often adhere together with the pedicel attached, forming an ovoid body crowned by a pair of styles. Each fruit has 10 ridges and is covered with short hairs. The vittæ, which contain the essential oil, are very numerous, each mericarp being provided with about 15. The value of Anise at Bombay is Rs. 5 to Rs. 6 per Surat maund of 37½ pounds.

The fruits of both the Star anise and *Pimpinella anisum* are imported very largely into Europe; the shipments from Russia of the last-named were formerly enormous. The principal distilleries of this oil are in Germany. Besides the large consumption of Anise in the East and in Russia, a large quantity of the essential oil is required by France for the manufacture of such liqueurs as Ratafia d'Anis, Absinthe, Anisette, Eau de vie d'Hendaye, Eau verte stomachique, &c.; in Germany, for the preparation of Anisette, Absinthe, Pfeffermünz-liqueur, Roscan aromatique, Kalmus liqueur, &c.; in Italy, for Rosolio di Torino; and in England, for Usquebaugh. The European consumption has, however, considerably declined during the last few years. This is indicated by the falling off in the exports from Russia; thus

In	1886	shipments	amounted to	2195	tons	from port of	Libau.
„	1887	„	„	1917	„	„	„
„	1888	„	„	1300	„	„	„
„	1889	„	„	1069	„	„	„
„	1890	„	„	570	„	„	„
„	1891	„	„	760	„	„	„
„	1892	„	„	731	„	„	„
„	1892	„	„	75	„	St. Petersburg.	

In Spain, the principal consuming market, the consumption of brandy, and with it that of Anise oil, have been reduced in the course of a few years, as a result of the high spirit-duty, to an almost incredible extent. In Austria, which, next to Spain, was the largest buyer of Anise oil, the public taste has undergone a

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change, and during recent years preference has been given to the artificial Cognacs.

Oil of Anise is said to be used in many compound perfumes, such as the Eau-de-Cologne of Marie of Dijon (but not that of Jean-Marie-Farina). It is also used considerably in medicine.

The yield per cent. of essential oil from the fruit of *Pimpinella Anisum* is as follows :—

Russian	2·8
Thuringian	2·4
Moravian	2·6
Chilian	2·4
Spanish	3·0
Levantine	1·3

Oil of Anise is a neutral, very pale yellow, somewhat syrupy liquid. It consists of two distinct bodies, one of which solidifies at 15° C. (59° F.), while the other remains fluid at all temperatures. The former is known as *Anethol*, or "Anise Camphor," $C_{10}H_{12}O$. The proportion of these two constituents varies slightly in different specimens of the pure oil, but generally the anethol constitutes four-fifths of the whole. By exposure to the air, the crude oil absorbs oxygen, the anethol being gradually converted into anisic aldehyde, and probably some resinification takes place in the terpene, this oxidation being accompanied by certain changes in the physical characters of the oil, it becomes more syrupy, its specific gravity increases, and its melting point is lowered. By repeatedly melting it in contact with air, the oil finally loses the property of solidifying by cold.

In order to obtain the anethol in a state of purity, it is freed from the liquid portion of the oil by repeated pressure between folds of filtering paper and then several times crystallised from alcohol of sp. gr. 0·85. It crystallises in soft, absolutely white, lustrous laminæ, having an odour similar to, but more agreeable and less rank than the crude oil, in fact representing the anise aroma in the purest and most perfect form. It is very friable, especially at 0° C.

Oil of *Pimpinella Anisum* appears to be almost identical with oil of Star Anise derived from a totally different plant, and cannot be distinguished chemically or optically, except by Eykmann's colour test hereafter described. They differ however in point of

congelation. They are marketed as distinct oils, and Dealers by practise can readily distinguish one from the other by the sense of smell alone.

The earliest scientific examinations of oil of anise were made by Cahours* and Gerhardt;† also by Kraut & Schlum.‡

It was formerly considered that the congealing point of oil of *Pimpinella Anisum* was 50° to 59° F. (10° to 15° C.) and that of "Star Anise" 35°·6 F. (2° C.); these figures are authoritatively given in "Pharmacographia" and the French translation of the same; in the Pharmacopæia Brit. 1885, and in the United States pharmacopæia, but it is now ascertained and acknowledged that those figures are *abnormal* and that the *true* congealing point of oil of *Pimpinella Anisum* is the same as that of oil of "Star Anise," viz., 15° C. (59° F.). The cause of this rectification of figures is owing to the discovery that the original observer, Cahours, in determining these congealing points, must have overlooked or omitted to take note of *the law of heat of congelation*, and recorded the congealing points by exposing the oil at rest to the low temperature, but with the thermometer not actually immersed in the fluid. Further,—that the authors of the works above referred to, and of all other text-books, have accepted Cahour's determination as correct, without verifying it by experiment.

Of course if Cahour's specimen was adulterated or was not virgin, *i.e.*, if part of the anethol had been abstracted from it, or if it had suffered change by oxidation, the uncongealable portion would be in excess of the normal quantity and so hold the remaining anethol in solution at a low temperature, but his Mémoire states that commercial oil holds more than four-fifths of anethol. The error and its source was pointed out by Umney in a Paper read at an Evening Meeting of the Pharmaceutical Society, 13th February, 1889.§ He there drew attention to the well-known fact that some liquids, such for example as water, saline solutions, &c., when at absolute rest, are capable of being cooled many degrees *below their normal point of congelation without becoming solid.* But when a liquid solidifies after being cooled below its normal freezing point,

* Ann. de Chim. and de Phys. [3], ii., p. 274; Compt. Rend. xx., p. 53.

† Compt. Rendus des travaux de Chimie, 1854, p. 65.

‡ Zeitsch. Ch. Pharm., 1863, p. 359.

§ Pharm. Journ. [3], xix., 647.

the solidification is accompanied by a disengagement of heat which is sufficient to raise the temperature from the point at which solidification begins, up to its *ordinary* or *true congealing* point. This physical law being applicable to anise oils, Mr. Umney continued to remark that:—"The solidifying points of star-anise oil, hitherto quoted, have been *abnormal ones*, due to their determination whilst the fluid was at rest. The *true congealing point* is the temperature to which the thermometer immediately rises on the solidification taking place. The 'Pimpinella' oil does not present such a marked difference in respect to its *abnormal* and *true* congealing points, but that of star anise presents a strange dissimilarity." The following table records results of Mr. Umney's investigations:—

SOURCE OF OIL.	ABNORMAL SOLIDIFYING POINT.	TRUE SOLIDIFYING POINT.
	Fahr.	Fahr.
Star anise, German	31	52
„ own distillation	24	49
„ direct import from Macao, China	34	56
„ Brokers' sample	36	54
„ Average of 10 Trade samples	35·5	55
Pimpinella anise, German	50	59
„ „ own distillation ...	50	59

As regards the fact that some liquids, such as Anise, Star Anise and Fennel oils remain liquid when submitted to a temperature many degrees below their normal point of congelation, it has been observed that this phenomenon (sometimes called "under-cooling") can be readily prevented by adding to the oil to be tested a few ready formed crystals, which can be obtained by first solidifying a small quantity of the oil in a mixture of salt and ice. The process is as follows:—The sample to be tested is cooled to about 12° or 14° C. by immersion in cold water, and then by means of a glass rod, a trace of crystallized oil is added. The whole mass should now solidify to a crystalline paste which ought not to liquefy under 15° C. Care should be taken in making this test, that the contents

of the tin or bottle subject to examination are completely melted and uniformly mixed.

The "melting point" of pure anethol—*i.e.*, the temperature at which a sample, after freezing, becomes completely liquid, is constant between 21° and 22 C°. It is ascertained by simply inserting a thermometer into a flask with melting anethol. The sp. gr. of pure anethol at 25° C. is 0·986. Its boiling point is constant at 234° C.

Pure, fresh oil of anise has a sp. gr. of 0·985 at 15° and 0·980 at 20° C. (The new United States Pharmacopæia, seventh decennial revision, 1890, states it 0·980 to 0·990 at 17° C.) Of course the sp. gr. of any given sample depends on its anethol content. Commenting on this fact, Squire observes in a recent paper on oils of anise, * "supposing melted anethol to have a sp. gr. at 60° F. of 1·010 and the terpene ·870, then 10, 20 and 25 per cent. of terpene will give specific gravities of ·996, ·992, and ·975 respectively, which covers the maximum and minimum of fresh oils as generally met with. The sp. gr. of the oil depends, secondly, on the amount of oxidation of the anethol into anisic aldehyde" (the sp. gr. of which is 1·126 at 15° C.).

In the samples of anise oils examined by Squire,† the polarising rotation in a 200 m. m. tube varied between + 2½° and —4½°, but were usually slightly lævogyre, a property which apparently had no connection with the source of the oil, was unalterable in a year, and was greater in the more liquid portion of the oil than in the solid. Pure anethol being probably optically inactive.

Oil of anise is sometimes adulterated with oil of Fennel. This can detected by the polariscope; pure recent oil of anise examined by be Flückiger and Hanbury in a 50 m. m. tube deviated the ray only 1°·7 to the left; oil of Sweet Fennel examined in the same way deviated the ray 29°·8 to the right; oil of Bitter Fennel (French), 4°·8 to the right, and that of German Fennel 9°·1 to the right. This dextrogyre power is attributed to the hydrocarbon in the Fennel oil differing in its properties to that in the Anise oil.

Anethol is isomeric with the camphor of Fennel oil, which, for this reason is imported from Russia and Austria for the express purpose of adulterating Anise oil, frequently to the extent of 90

* Pharm. Journ. [3], xxiv., p. 105.

† Ibid.

per cent. This sophistication is easily detected by heating the suspected sample, when, if anethol of Fennel be present, its odour becomes apparent.

Anethol requires for solution three parts of rectified spirit and 200 parts of proof spirit. As oxidation proceeds, the solubility increases, till the oil mixes with rectified spirit in all proportions and dissolves in about 100 parts of proof spirit. Star anise oil, however, appears to contain a small quantity of some constituent insoluble in proof spirit, as even after warming the solution is slightly turbid (Squire). Spermaceti may be detected in oil of anise by agitation with cold rectified spirit; the spermaceti being insoluble therein. Pure oil of anise is recorded as being soluble, in all proportions, in cold alcohol of sp. gr. 0·806, and in 2·4 parts alcohol of sp. gr. 0·84 at 25° C.

The new United States Pharmacopœia says:—Absence of volatile oils containing phenols can be ascertained by adding a drop of ferric chloride solution, when the oil should not assume a blue or greenish colour. When dropped into water without agitation, the oil should not produce a milky turbidity, indicative of the presence of alcohol.

It is averred that by the "Eykmann test" oil of pimpinella may be distinguished from oil of star anise. This test depends on a colour re-action; the reagent consists of a saturated solution of hydrochloric acid gas in absolute alcohol; it has a sp. gr. of 0·970, and contains 27 per cent. by weight of hydrochloric acid gas. On addition of this reagent, which is best used in considerable excess, the pimpinella oil should give a rich blue coloration, changing into a more or less brownish red, and the star anise oil a yellow or brownish-yellow colour, usually (but not always) changing to a rich red. Mr. Squire remarks* that with an acid of half the above-named strength, the characteristic blue colour with the pimpinella oil is not produced.

Anisoïn (better called *Anethoïn*) may be obtained by the action of stannic chloride or of strong sulphuric acid either on solid or liquid Anethol. Anisoïn is a white, inodorous solid, which fuses a little above 100° C., and, when further heated, burns with a brilliant flame and an aromatic odour. It is heavier than

* Pharm. Journ. [3], xxiv., p. 105.

water, insoluble in water, almost insoluble in alcohol, even on heating; more soluble in ether and volatile oils.

Hydride of Anisyl $C_8H_8O_2$ Syn., *Anisylous acid, Anisic aldehdye, Anisol,** is prepared by gently heating oil of anise for about an hour with three times its volume of nitric acid of sp. gr. 1·106 (14° Beaumé). The heavy oil which is thus formed is washed with dilute potash and distilled. The distillate is agitated with a warm solution of acid sulphite of sodium of sp. gr. 1·25; the crystalline compound thus formed is collected on a funnel, thoroughly washed with alcohol, dissolved in as little hot water as possible, and the solution heated with excess of strong sodic-carbonate, when the anisic aldehyde separates out and floats on the surface. It is then purified by re-distillation. Thus obtained, it is a yellowish liquid with a burning taste and an aromatic odour resembling that of the Hawthorn, for which reason it is known commercially as "Aubépine."

Its specific gravity has been recorded as 1·09 at 20° C., and its boiling point 253°-255° C., but it is possible that the earliest observations were not determined from absolutely pure or fresh specimens of this rather unstable preparation. Messrs. Schimmel & Co. state that the pure anisic aldehyde manufactured by them boils at 245°-246° C., and has a sp. gr. of 1·126 at 1°5 C.†

It is almost insoluble in water but is soluble in all proportions in alcohol and ether. It possesses the property peculiar to aldehydes of forming crystalline compounds with the acid sulphites of the alkali-metals.‡

At an ordinary temperature anisic aldehyde is liquid, but in a freezing mixture it congeals to a solid mass of crystals, melting at —4° C. By cooling it carefully to —10° C. it remains liquid, but congeals immediately upon the introduction of the slightest trace of the crystalline body, under an advance of temperature to —4° C. In contact with air, anisic aldehyde easily oxidises to anisic acid, it should therefore be kept in well stoppered bottles, filled as full as possible. It is useful in the manufacture of soap, and extracts and combines particularly well with oils of orange, petitgrain, or oils of kindred odour.

* Cahours Ann. Chim. Phys. [3], xiv., p. 484; xxiii., p. 354.

† Bericht, April, 1893.

‡ Ann. Chem. Pharm., lxxxv., p. 268.

Australian Anise,—the fruit of *Seseli Harveyanum*, Mueller, is said by Maiden* to be locally used in Australia under the name of "Anise." It grows at an altitude of about 5000 feet on the Snowy Mountains. In appearance and flavour the fruits resemble those of Indian Fennel rather than anise.

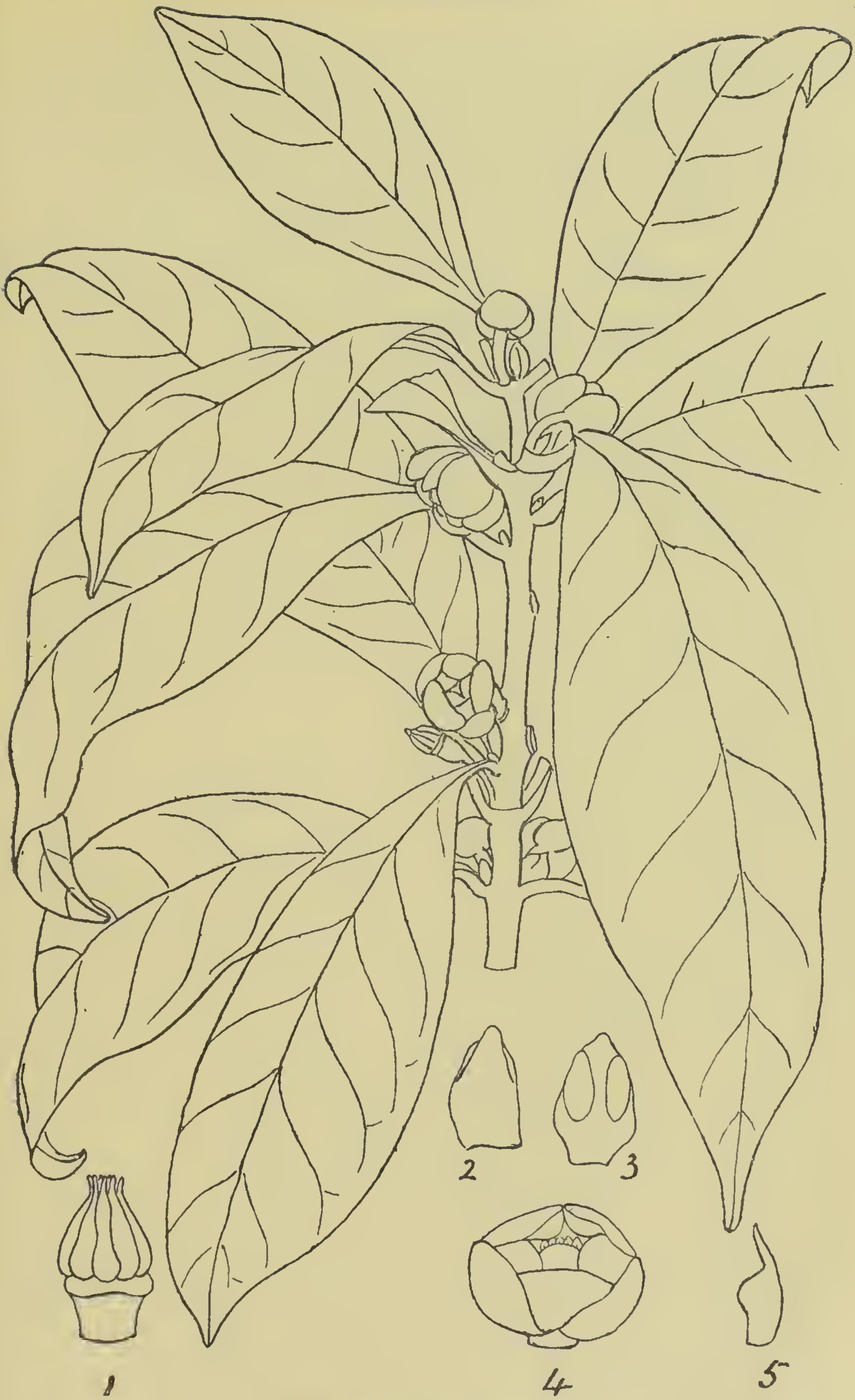
Star Anise, or "Badiane." The true Chinese "Star Anise" is the fruit of *Illicium verum*, Hooker, which was for the first time figured and described in Curtis's Botanical Magazine, July, 1888, t. 7005.

Illicium (meaning "allurement," from its odour and attractive appearance) is a genus of aromatic evergreen shrubs or small trees, *Magnoliaceæ*, found in Southern China, Japan, the Khasia Mountains, and in the south-eastern parts of the United States. Their smooth entire leaves exhale when bruised, a strong aromatic odour, due to the volatile oil contained in minute pellucid vessels, which may be seen by means of a lens. The flowers are borne singly or in threes from the sides of the branches, usually of a yellowish colour, except in one species where they are dark purple, and in *I. Verum*, where they are tinged with red. They have a calyx of 3 or 6 sepals, coloured in the same manner as, and scarcely distinguishable from, the petals, which vary in number from 9 to 30, and are arranged in several series, the innermost ones being the smallest; the stamens are numerous, and the ovaries, varying from 6 to 18, are crowded together in a circle. The fruit, at maturity, resembles a star, consisting of a variable number of one-seeded flattened cells arranged round a central axis.

Dr. Bretschneider, in Dec., 1880 (then medical officer to the Russian Embassy at Pekin), in "Notes on some Botanical questions connected with the Export Trade of China,"† states "the plant which produces this article ("Chinese Star anise") is still unknown to botanists," and he then goes on to remark: "The first authentic information concerning the actual habitat of the star anise tree was furnished by Mr. Piry, in his 'Report on the Trade in the Port of Pakhoo' for the years 1878-1879, in which star anise is said to be brought for exportation to Kin-chow and Pakhoi, from the province of Kuangsi, two districts in that province producing the

* Notes on Australian Economic Botany, p. 135.

† "China Review," ix., p. 283.



ILLICIUM VERUM, Hooker.

1.—Carpels.
2.—Back view of stamens.
3.—Front view of same.
4.—Flower.
5.—Side view of carpel.

article, Lung-chow on the borders of Annam, and the country about Po-se, on the West River close to Yunnan." Dr. Bretschneider adds a translation from the well-known work on Chinese materia medica and natural history, "Pen t'sao Kang mu," vol. xxvi., fol.

ILLICIUM RELIGIOSUM of Japan.

1.—A flowering branch (reduced).
2.—Vertical section of flower (enlarged).
3.—Back view of Stamens ,,
4.—Front view of same ,,
5.—Pistil, receptacle, and carpels ,,

62, in which it is stated that star anise grows in the mountains near the Tso-Kiang and Yu-Kiang (rivers), and that the kind most valued in China, grows in Kuang-si and Kuang-tung and in Annam. Dr. Bretschneider remarked that both the above rivers are in Western Kuang-si, the first being a tributary of the West River. The city of Po-se mentioned by Mr. Piry, is situated on it. The Tso-Kiang is a southern tributary of the Yu-Kiang.

In the Pharmaceutical Journal of 11th Aug., 1888, the above mentioned facts are referred to by Mr. Holmes, who there remarks :—"These notes appear to have attracted the attention of the late Dr. Hance, who in October, 1881, forwarded seeds of the true plant received from Pakhoi to Kew. In the same year fruit and fragments of the leaves were forwarded by Mr. C. Ford from Hong Kong Botanical gardens, to Kew. A few seedlings of the plant obtained by Mr. Kopsch, Commissioner of the Chinese Imperial Maritime Customs at Pakhoi, were grown in the Hong Kong gardens and flowered in November, 1886, when the plants had attained the height of 9 feet. Some seedlings sent by Mr. Ford to Kew in 1883, flowered at Kew in 1887, and from these the excellent plate given in the Botanical Magazine was drawn."* Sir Joseph Hooker describes the plant as a new and hitherto undescribed species and points out that it must be placed in quite a different section of the genus from that to which *I. anisatum*, L., belongs, since it has broad obtuse perianth segments and the peduncles are not bracteate at the base. The fruit is as represented by Gærtner, *I. anisatum*, Carpologiæ, vol. i., p. 338, t. 69.

The stellately arranged, boat-shaped carpels of most commercial specimens of *I. verum* are eight in number, and although each is furnished with a beak when growing, in the commercial article they are almost invariably broken off.

The character mentioned by Gærtner as distinguishing the Chinese drug, viz., that the apex of the carpel is pressed in or extended horizontally, is not a distinguishing feature. In the young state of the fruit all the carpels are erect, but spread outwards as they arrive at maturity; hence, the position of the beak will differ according to the degree of ripeness of the fruit when gathered. In many specimens of the Chinese drug it will be found pointing upwards. The notch or depression close to the beak just at the end of the upper or ventral edge of the carpel is more shallow in the Chinese drug than in the Japanese, and the fruit is generally *larger* by about one-third and has more of the carpels *developed* to their *full size* than the Japanese fruit.

It has been observed that the fruit of the Japanese star anise when wetted and laid on a piece of blue paper reddens it

* Bot. Mag., t. 7,005, July, 1888.

RIPE STAR ANISE OF DIFFERENT SPECIES.

1.—Chinese Star Anise, and profile of beak of carpel.
2.—Illicium majus ,, ,,
3.—Illicium Griffithii ,, ,,
4.—Illicium religiosum and profile of beak of carpel and seed.
5.—Seed of Illicium religiosum as represented by Eijkman.
6.—Seed of Illicium anisatum, Loureiro, as represented by Eijkman.
7.—Section through the testa, I. religiosum, ,, ,,
8.— ,, ,, I. anisatum, ,, ,,

Fruits natural size—parts enlarged.

immediately and strongly, while the Chinese star anise causes only a very faint red coloration.

Mr. Holmes remarks that "The leading features in the plant appear to be the solitary axillary globular flowers, which do not expand fully, the segments remaining convex, the inner segments being red, and the ten stamens in which the filament forms with the connective an ovoid body. The peduncles are curved and barely half an inch in length. A very similar plant, but with smaller and yellowish flowers, has been grown at the Botanical Gardens, Regent's Park, since 1870, under the name of *I. anisatum*, but the leaves of this species have a sassafras taste.

The leaves of *I. verum*, Hooker, differ from those of *I. religiosum* in having the mid-rib prominent on the upper and not on the lower surface, and the taste is astringent and terebinthinous.

The fruit of Chinese Star anise has been found by Dr. Ferdinand Oswald to yield 78·4 per cent. of carpels and 21·6 per cent. of seed. The yield of essential oil from the carpels was 5·6 per cent., while only 2·7 was obtained from the seed ; these figures being somewhat higher than those previously given by Meissner. The seeds contain 22 per cent. of fixed oil, while the carpels yield only 1·3 the sp. gr. of the essential oil was found to be 0·985 at 15° C., and 0·980 at 20° C.

Investigations made by Messrs. Schimmel & Co. into the nature of oil of Chinese star anise* throw some light upon the character of the constituents of low boiling-point, viz., the terpenes contained in it. The fraction in which these constituents occur boils at 157° and 175° C., and contains :—*Dextro-pinene.* Boiling point 157°-163° ; optical rotation + 21° 30′ (100 m. m. tube) characterised by the Pinene-nitrol-amine base of a melting point of 122°-123°. But the chief constituent is *Lævo-Phellandrene*, boiling point 170°-175° ; optical rotation —5° 40′ (100 m. m. tube). Melting point of the nitrite 102°.

The highest price for Star Anise oil in the last 30 years was in 1867, when it reached 12s. per lb., the lowest quotation being 5s. 4d. per lb. in 1893.

* Bericht, April, 1893.

Japanese Star Anise. *Illicium religiosum*, Siebold and Zuccarini, Flor. Jap., i., t. 1.; Bot. Mag., t. 3965, Syn., *I. anisatum*, Linn. and Loureiro, Bentley and Trimen, Med. Plant., i., t. 10, was for many years supposed to be the tree yielding the true Chinese Star anise, but, as now pointed out by Hooker, *I. anisatum*, or *religiosum*, are species with peduncles bracteate at the base and long, spreading inner perianth segments, therefore belong to a different section of the genus from *I. verum*.

The Japanese tree is locally known as "Shikimi no Ki," and generally considered in Japan to be poisonous. The name is also written "Hana Shik'mi," "Sikimi," and "Skimi"; it appears to be derived from "Ashikimi," meaning Evil fruit. The Chinese name is "Mang-thsao," Mang meaning "mad," and thsao "herb," because it is said to cause paroxysms of frenzy in human beings. According to Iwasaki Jose, author of the "Honzo Zofu," it is called "Hana-no-Ki" in the province of Harima, and "Koshiba" in the province of Enshu. According to Yamomoto Boyo, author of the "Hiaku-shinko" (Description of a Hundred Drugs), *I. religiosum*, both in China and Japan is called "Dai ui Kio." According to Ito Keisuke, it is also called "Irirshi ya mu."

Many botanists have taken *I. religiosum* and *I. anisatum* to be identical, but Siebold mentions points of distinction, saying, for instance, that the former is 25 to 30 feet high, or two or three times the height of the latter; that its leaves are broader in the middle, and more glaucous and pale on the under surface; he also observes that it has a less number of stamens and petals than *I. anisatum*.

Although the tree now grows wild in many parts of Japan, it is not a native, but was introduced from China or the Corea in ancient times by the Buddhist priests, and planted around the Japanese temples, being used when in blossom for adorning the altars and tombs. The yellowish bark has an aromatic taste, also the leaves, and, these being powdered, are used in the manufacture of long, thin, cylindrical pastilles ("sen-ko") as incense in the Buddhist temples and in religious services. Formerly such straight or circularly bent cylinders, which, when lighted, burned regularly, were used as time-measures.

The tree has been found in the neighbourhood of Nagasaki, in the centre of Nippon, near Tokio; upon the Iwaya mountains, near

Yokosuka; in large quantities upon the island of Hachijo, in the province of Izu; and in the provinces of Sagami, Enshu, Tamba, Musashi, Hizen, Chozhu, &c. The leaves are considered to be poisonous, and instances of poisoning therewith are on record.*

In the unripe condition the fruit is green and juicy, and contains much essential oil. When ripe it opens rapidly lengthways along the upper side in the same manner as the Chinese fruit. The yield of oil from the ripe fruit is estimated at one per cent., but it is different in odour to that of the Chinese, resembling a mixture of *Laurus nobilis*, cloves and nutmeg. The number of carpels is eight, as in the Chinese anise; the entire fruit is about one-third less in diameter than this last, is of a paler yellow-brown colour, more shiny and more woody; the carpels much shrunk in upon one another and wrinkled†; only a few of them are generally developed at maturity; the curve or depression on the ventral suture near the apex is deeper and shorter, and hence the very short beak appears more erect than in the Chinese drug.

Information respecting the essential oil of the *leaves* of *Illicium religiosum* was furnished by Eijkman in the memoir above referred to. He found that "on submitting 40 kilos of fresh leaves to steam distillation and cohobation, he obtained 177 grams of essential oil, or nearly 0·44 per cent.‡ The oil was strongly refractive, nearly colourless, or faintly yellow, and becoming darker on keeping. Its sp. gr. was 1·006 at 16°·5 C. Its odour recalled that of a mixture of laurel, camphor, cajuput and nutmeg, the last being especially perceptible in the aqueous distillate. The peppermint-like odour ascribed by some authors to the "shikimi" leaves was not observed either in the essential oil or distilled water, or in the slightly bruised leaves.

As a result of subsequent investigation, Eijkman reports that the volatile oil of the leaves consists of Eugenol and two constituents that he calls *shikimol* and *shikimene*. Shikimol is represented by the formula $C_{10}H_{10}O_2$, boils at 229° to 231° C., and is apparently identical with *safrol*. Shikimene is a hydro-

* Pharm. Journ. [3], xi., p. 1046.

† Eijkman in Mittheilungen der Deutschen Gesselschaft für Natur und Völkerkunde Ostasiens, xiii., Yokohama, 1881.

‡ Recueil des travaux chimiques des Pays Bas, i., p. 32 and 985.

carbon having an odour recalling that of lemon oil, boiling at 170° C. (the boiling point of safrene is 156° C.).

In the fruit of *Illicium religiosum*, Eijkman found protocatechuic acid and two hitherto unknown compounds requiring further investigation.

There are several species of the genus *Illicium* to which *I. verum* is more nearly allied than to *I. anisatum*, all having globose flowers, but all differing from *verum* in the increased number of perianth-segments, stamens and carpels. These are :—

Illicium parviflorum, Michaux.* This species is a native of Western Florida, the hilly regions of Georgia and Carolina. It is distinguished by the smallness of its flowers, the perianth being composed of from 12 to 15 unequally shaped segments, the exterior ones being short and green, the interior ones thinner, larger, and of a pale yellow colour. The stamens generally number six or nine. Carpels 12 to 15, of very agreeable odour. The bark has exactly the odour and flavour of sassafras root, and the leaves are odorous.

One of the latest novelties in essential oils prepared by Messrs. Schimmel & Co.† is termed "Anise bark" oil. The bark yielding this distillate was recently imported from Madagascar, and resembles Massoi bark in its external appearance. The aroma is, however, quite distinct from this latter. The botanical origin of the bark has not been determined, and the fact that the tree yielding it grows in an as yet unknown part of the island, renders its identification a matter of great difficulty, but there seems a probability of its being the produce of *I. parviflorum*, Michaux.

Messrs. Schimmel state that "the bark yields fully 3½ per cent. of a light yellow oil, the odour of which reminds of Safrol and Tarragon. It has a spicy taste, but is only slightly sweet. Its sp. gr. is 0·969 at 15° C. Optical rotation—0° 46′ in a 100 m. m. tube. Refraction equivalent for the sodium line at 16° 1·52510. This oil contains a small quantity of anethol, but consists principally of the isomeric fluid-anethol, the *methylchavicol* of Eijkman.

* Flor. Bor. Amer., i., 326; Baillon, Hist. des Plantes, i., p. 151, f. 191, 194; Ventenat, Jardin de cels., t. 22; Loiseleur Des Longchamps, Herbier de l'amateur, t. 330.

† Bericht, April, 1893.

Illicium Floridanum, Ellis,* is a native of Western Florida, in the vicinity of the Mississippi. It differs from other species by its perianth consisting of three varieties of segments, the outer ones being short, wide, and of whitish-green; beneath these are segments equally wide and membranous, of dark reddish-purple colour; and in the interior the segments are of the same colour as the last, but more elongated and straighter. These three different formations blend gradually from one to the other. Its carpels number about the same as in the last mentioned species, 13, but neither of them are known in (European) commerce,† although both are of agreeable odour and are probably used in America for the same purposes as the Chinese fruit.‡

Illicium Sanki, Perr. Baillon§ is of opinion that this species, which furnishes the star anise of the Philippines, is only a form of *Illicium anisatum.*

Illicium Griffithii, Hooker and Thomson.|| This species is a native of eastern Bengal growing in dense humid woods on the Bhotan and Khasia hills at an altitude of 4,000 to 5,000 feet. It is a shrub with angular glabrous branches and leaves larger than those of *I. anisatum*, being 2 to 4 inches long and 1 to 2 inches broad, acute at both ends, coriaceous, shining. The flowers much resemble those of *I. parviflorum*; they have 6 orbicular sepals and 18 petals, the outer being oval and the inner ones smaller and narrower. It is readily distinguished from the Chinese and Japanese species by the strongly beaked carpels, numbering 12 to 15; these are very equally developed, have a thin fleshy epicarp, a woody endocarp and short, subulate, incurved beak. After being packed in the dried state, and transported down to the bazaars, the slender portion of the beak is usually broken off, but its incurved direction remains noticeable. All parts of the plant are aromatic,

* Act. angl., 1770, 524, t. xii.

† Baillon, Recherches sur l'origine des Badianes ou Anis étiolés, in "Adansonia," viii., 1; Dictionnaire encyclopédique des sciences médicales, viii., p. 81.

‡ In the American Journal of Pharmacy, May, 1885, is an elaborate paper on *Illicium Floridanum*, illustrated by four plates showing the minute structure of the fruit, seed, leaves, stem, bark and root of the plant.

§ Hist. des Plantes, i., p. 185, note 1.

|| Flor. Brit. Ind., i., 40; and Flor. Ind., i., p. 74.

even in the dried state. The fruit has not, either when fresh or dried, at all the smell of anise, but possesses a faint agreeable odour like that of the leaves and wood. It is rather a local plant in the Khasia hills; Griffith found it at Mamloo, near Churra; it occurs also in the deep valley of the Kala-pani.

Illicium majus, Hooker and Thomson,* is a native of Thoung Gain range in Tenasserim at an altitude of 5,500 feet. It is a shrub about 30 feet high with leaves from 4 to 6 inches long and 1½ to 2 inches broad, sharply acuminate, coriaceous, glabrous, shining above, petiole 1 inch. The flowers are pink. Pedicels 1 to 3 inches, subterminal, solitary or fascicled. The segments of the flower are about 16, the sepals and petals being orbicular, ciliate, the inner petals broad-oval. Filaments short, broader than the oblong anthers. It is believed that this species furnishes the star anise known in the Singapore bazaars as "Bunga lawang," a fruit remarkable for their dark brown, almost black, colour; its carpels number 11 to 13 and are very equally developed. The depression near the end of the ventral suture is longer and shallower than in *I. Griffithii*, so that the short beak appears less incurved. The taste has a strong resemblance to mace, but lacks the bitterness so manifest in the fruit of *I. Griffithii*.

I. cambodianum, Hance.† *I. cambodgianum*, Pierre.‡ This is a broad-leaved species with long-peduncled flowers, native of the Elephant Mountains in Cochin China.

In describing several varieties of gum obtained from Australian trees of the genus *Panax* (*Araliaceæ*), J. H. Maiden states,§ that the odoriferous principle possessed by the panax gums is derived from the bark of the trees, most of the species having a strong smell aniseed and celery, and one being hence termed the "Celery tree."

Fennel.

As above observed, *anethol* forms the chief constituent of oil of Fennel, *i.e.*, the volatile oil derived from different species of

* Flor. Brit. Ind., i., p. 40.

† Trimen's Journ. Bot., 1876, p. 240.

‡ Flore Forestière Cochinchin, t. 4.

§ Proc. Linn. Soc., N. S. W., vii., p. 35.

Fœniculum, a genus of umbelliferous plants with finely dissected leaves, no involucres, and yellowish flowers. This genus is distinguished from *Anethum*, to which it is very closely allied, by the fruits being somewhat compressed from side to side and not from back to front. *F. Vulgare*, Gærtner *(Anethum Fœniculum*, Lin.*)*, the common Fennel, is wild in most parts of Europe except the North and East, is especially common in the Mediterranean region, and extends to Southern Russia, Asia Minor, Persia and India. In England it is usually found on dry chalky soil, at no great distance from the sea ; it is also found inland in chalky districts, but merely in a semi-wild state except where cultivated as a garden herb. In the wild state, it is variable as to size, habit, shape and cutting of leaf, number of rays in the umbel and shape of fruit, and, as it has also been under cultivation for centuries and for different purposes, there now exist several well-marked varieties.

The fruits are commonly called "Fennel seeds;" they vary much in length, breadth and other characters, and are of very different commercial value. Fennel fruits are thus described in the British Pharmacopœia:—"About three lines long and one line broad, elliptical, slightly curved, beaked, having eight pale brown longitudinal ribs, the two lateral being double; taste and odour aromatic." Wild fennel fruits are short, dark-coloured, and blunt at their ends, they have a less agreeable flavour and odour than those of sweet fennel.

The most esteemed fennel fruits vary from three to five lines in length, are somewhat obtuse at the ends, pale greyish green in colour, of very fragrant odour and agreeable aromatic taste. Fennel fruits are frequently distinguished in commerce as *shorts* and *longs*, the latter being the most valued.

Sweet Fennel, also called "Roman Fennel," frequently mistaken to be *Fœniculum dulce*, D.C. (which is generally used as a table vegetable), is probably *F. Sativum*. It is much cultivated in the South of France, especially in the vicinity of Nismes. It is a very vigorous plant, forming 25 to 30 rays to the umbel ; its fruit two-fifths of an inch long, or twice as long as that of the wild plant, it is oblong or obovate oblong in form and often strongly curved, the ribs are wider and more prominent and the vittæ smaller. So different do they appear from the common form, that

they have been supposed the produce of a different species; but it is a known fact that the plant being of comparatively long life, the fruits which it bears year after year, gradually diminish in size, and that in about four or five years, it reverts in so remarkable a manner to the form of the wild plant (the Bitter Fennel), which grows in the same locality, that it cannot be distinguished from it. This curious fact has been experimentally demonstrated by Guibourt (Hist. des Drogues, iii., p. 233).

F. Dulce, D.C., is a smaller plant than *F. sativum*, it has fewer rays to the umbel and may be a distinct species (not a mere form or variety).

German fennel, or **Saxon fennel**, is mostly produced near Weissenfels in Saxony. The fruits are ovoid-oblong, rather compressed laterally, slightly curved, glabrous and dark brown in colour, but seen in bulk, are of a greenish-brown; their aromatic flavour is saccharine and their odour distinguishable from the other varieties. The plant is figured in Bentley & Trimen, Med. Plant., t. 123.

Indian fennel is produced by a small annual form of the plant, *F. Panmorium* D.C., which is largely cultivated in India. It is generally considered to be a variety of *F. capillaceum*. Watt, however, in his "Dictionary of the Economic Products of India, iii., p. 406," says that the perennial, *F. Vulgare*, Gærtner, is commonly cultivated at all altitudes up to 6000 feet, and attains a height of 5 to 6 feet; he adds that several species are cultivated which do not appear to have been botanically recognized.

Generally in India, the fennel seems to be grown only in small patches on homestead lands, as a cold-weather crop. In Bombay, however, it is cultivated to a large extent.

The following account has been given by the Director of Land Records and Agriculture, dated September, 1889:—" In 1887-1888 Fennel occupied 1454 acres, of which 834 acres were in Khándesh. It is grown in some districts of gujarat and the Deccan. In the former district it is grown in good light soil, moderately manured (10 cart-loads to the acre); the land is ploughed, harrowed, and rolled three times between June and October. About 9lb. of seed per acre is scattered by hand into beds, which are irrigated once a fortnight until January. The crop is (injudiciously) cut in rather

a green state, and allowed to lie on the ground for a few days. The yield per acre varies greatly, 720lb. being considered a fair average. In the gardens in the Deccan it is sown at any time. The probable total yearly crop of India is estimated at 13,000 maunds.

The yield of volatile oil from Indian fruit has been estimated at 3 per cent.

The principal amount of Fennel fruit sent to the Bombay market is from Jubbulpore, Kupperwanj and Khándesh, and has increased in value during the past ten years, thus, according to published statistics, the total exports in 1881-82 were 2201 cwt., in 1887-88, they were 4353 cwt., valued at ℞ 31260. Almost the whole quantity was exported from Bombay in the latter year, viz., 4337 cwt., Madras sending 15 cwt., and Scinde 1 cwt. Of that total, Great Britain received only 221 cwt., France 957 cwt., Belgium and Austria each 200 cwt. The rest went to Eastern ports.

The best varieties of Fennel, such as the "Sweet" and the "German," yield from 3 to 4 per cent. of essential oil.

Under the name of "Anise" a sample of Japanese Fennel was introduced into the market in 1889, which, although it had the aroma and taste of Fennel, presented an extraordinary similarity to Anise in the form and size of the grain. Any doubt that might at first have existed, was removed by the aspect of the plants that resulted from sowing some of the seed. According to Rein, the Japanese Fennel is derived from the same species as the European, *F. Vulgare*, Gærtner (*F. capillaceum*, Gilbert), and is much used in Japan.

Oil of Fennel possesses considerable rotatory power; this property however, varies much in the different commercial oils, that of oil of sweet fennel exhibiting it to by far the greatest extent; in all of them, however, it is dextrogyre. The rotatory power was found to be due entirely to the liquid hydrocarbon contained in them; hence, in proportion to the quantity of this in the different varieties of oil, so will be their rotatory power, and hence also the feeble rotatory power of pure oil of anise from its consisting almost wholly of anethol.

Examined in a tube of 50 m. m. Flückiger and Hanbury found the oil of sweet fennel deviated the ray 29°·8; oil of bitter fennel 4°·8 and the German oil 9°·1, all to the right.

The fruits of the Fennel (and of all umbelliferous plants) should be *thoroughly* mature and dry before submitting them to distillation, otherwise the resulting oil will be of very unpleasant odour.

Three varieties of oil of Fennel are distinguished in commerce: —Oil of Sweet fennel, oil of Bitter fennel, and oil of German or Saxon fennel (grown in the Lützen-Weissfels district). The first, which has a perceptible sweet taste, is the most valued; it is obtained from the south of France. It is also grown in Roumania and in the province of Puglia, in Italy.

The price of fennel oil varies considerably, the value depending upon the content of anethol. Normal oil of fennel should contain about 60 per cent. of anethol. In Austria it is extracted partly or entirely from the fennel oil to serve as a mixture for oil of Anise.

An oil of fennel is distilled from the young shoots of a wild species growing near Granada, in the south of Spain, the plant there attaining a height of over six feet. The oil is identical with the so-called "Bitter Fennel" oil distilled in the south of France.

An odour somewhat resembling fennel and lemon, is the resin of Manilla Elemi:—

Elemi.

The botanical source of this concrete resinous exudation is undetermined, but it is possibly *Canarium commune*, Linn. (*Burseraceæ*)*; at least, that is the opinion of Bentley and Trimen, and in their valuable work on medicinal plants they state that at different periods the resinous products of several trees have been described under the name of Elemi; the more important of which being Mexican or Vera Cruz Elemi, obtained from *Amyris elimifera*, Royle; Brazilian Elemi from several species of *Icica*; and the present variety, known as Manilla Elemi, which has been conjecturally referred to *Canarium commune*, Linn., in the British Pharmacopœia, but without any reliable data. Of late years the Mexican and Brazilian varieties have almost disappeared from commerce, the only one now obtainable being that known as Manilla Elemi, from being chiefly or entirely imported from Manilla.

* Roxb. Fl. Ind., iii., p. 137; D. C. Prodr., ii., p. 97; and W. and A. Prodr., p. 175.

Canarium commune, Linn., is a tree of 40 to 60 feet in height, native of Amboyna, Luzon, Sunda, the Moluccas and Penang. It is also cultivated in Java and has been grown in the Gardens in Calcutta, where, however, it did not thrive. This tree is not identified as the certain source of the Elemi, although the question has occupied much attention by several observers. It is described and figured by Bentley and Trimen in Med. Plant., t. 61, from a specimen in the British Museum, a woodcut is also furnished, drawn from specimens of a variety of *C. commune* (or species of *Canarium*) received by them from H.M. Consul at Manilla, which may be probably that from which Manilla Elemi is obtained. The Consul communicates the information as follows :—" The tree is very rare or almost unknown close to Manilla, but is abundant in the hills about 20 miles off, where it extends from the valleys to an elevation of 2000 feet. The tree is 30 or 40 feet high, and the greenish flowers appear in April and May ; the wood is very hard and abundance of the white resin ('Brea') exudes from the cut bark. Two kinds of this tree are distinguished and called locally, *Saïn* and *Bīlī*; the latter has larger leaves and affords the best "Brea." The illustration on next page is copied from a woodcut in Bentley and Trimen's Med. Plants., drawn from the specimens supplied by the Consul at Manilla as above mentioned. These figures show the young flowers (figs. 1 and 2), fruit (fig. 7), and a leaflet (fig. 8), of the Saïn variety. The tree appears to differ from *C. commune* only in its smaller and less tapering leaflets, more deeply-lobed calyx and longer and narrower fruit. Fig. 3 shows a flower enlarged ; fig. 5 a vertical section of the calyx and pistil ; fig. 4 a petal ; and fig. 6 a transverse section of the fruit.

Messrs. Bentley & Trimen further observe that these above-mentioned specimens appear to agree with another plant described by Camelli as *Terebinthus Luzonis altera*, which the Consul states affords a more copious white and odoriferous resin than the *Laguaan*.* The native names he gives for this are *Sagnan*, *Pilis*, and *Pilavay*, the two first of which may well be other forms of the names *Saïn* and *Bīlī*. Camelli's excellent unpublished drawing of the plant (MSS., Sloane, fol. 151) agrees well with the Consul's specimens."

* *Laguaan*, *Lauvan* and *Pagsaingan* are native names for *Terebinthus Luzonis prima* of Camelli in Ray's History of Plants, and he says the plant is called *Arbol de la Brea* by the Spaniards. His drawing in the British Museum (MSS., Sloane, 5288, fol. 227) fairly represents *C. commune*.

CANARIUM SP.

The species yielding Manilla Elemi.

Canarium commune, Linn., has been described by Bennett (Lecturer on Botany at St. Thomas' Hospital),* as "a well known tree, native of the Malayan Peninsula and Archipelago, and extensively cultivated throughout India. The resinous exudation is imported into England from Manilla." Mr. Bennett states that there are about thirty species of *Canarium* distributed throughout Tropical Asia and the Malayan Archipelago, and in his valuable Paper describes eighteen of them and nine species of *Santiria* (Blume), also balsamiferous trees of the same order, *Burseraceæ*. He agrees *C. commune* to be the plant referred to by Roxburgh, De Candolle, and Wight and Arnott. His analysis is as follows:—"Leaves ¾ to 1½ foot in length, with elliptic or rotundate auricled deciduous stipules (the stipules were not apparent in Consul Rickett's specimens above referred to), and 7 to 9 acuminate leaflets. Panicle very spreading. Flowers white, very variable in size, the female larger; buds enclosed in ovate or rotundate tomentose bractes. Calyx campanulate, broadly 3-lobed. Petals tomentose above. Ovary glabrous, thickened upwards. Drupe ellipsoidal, subtrigonous, with a bony 1 to 3-celled stone.†

When fresh and pure, Manilla Elemi is a soft, granular, resinous, colourless substance; but it is often mixed with fragments of wood and other impurities, and is also sometimes of a greyish or blackish colour from the presence of carbonaceous matter. By keeping and exposure to the air it becomes harder and of a pale yellow tint. Its odour is strong and fragrant, somewhat resembling fennel and lemon, and it has a bitter, disagreable, pungent taste. At the temperature of about 212° F., it becomes soft, and if further heated it readily fuses and forms a clear resinous substance. Moistened with spirit of wine it breaks up into small particles, which, examined by the microscope present a crystalline appearance. The crystalline constituents *Bryoidin*, *Amyrin*, and *Elemic* acid have been isolated and studied by Flückiger,‡ and by Buri.§

* Pharm. Journ. [3], vi., p. 102.

† For further reference on this subject see Rumphius, Herb. Amb., ii., tt. 47 and 48; Annals of Botany, i., t. vii., f. 2 (flowers only); Gærtner, Fruct., ii., t. 102 (fruit); Ray, Hist. Plant., App., pp. 60 and 67; Blanco, Flor. de Filip, ed. 2, pp. 256, 546; König, in Annals of Bot., i., p. 260, t. 7, fig. 2; Miguel, Flor. Ind. Batav., i., pt. 2, p. 643; Lindl., Flor. Med., p. 170; Pharmacographia, p. 129 (but Flückiger and Hanbury do not appear to think that Manilla Elemi is the product of a *Canarium*).

‡ Pharm. Journ. [3], v., p. 142.

§ Ibid., vii., p. 157, and viii., p. 601.

Manilla Elemi is rich in essential oil. Flückiger and Hanbury state that on experiment they obtained by distilling 20 lbs. of the resin with water, as much as 2 lbs. 13 ozs. (10 per cent.) of fragrant colourless oil which was strongly dextrogyre. An oil of elemi examined by Saint Claire Deville, was found by that eminent chemist to be strongly lævogyre.* These contradictory results indicate that between the essential oils of *different sorts* of elemi there are as great differences observable in their physical properties as between the oils of turpentine and copaiba. It is now known that the principal constituent of ordinary oil of elemi is a dextro-rotatory *phellandrene* and an optically inactive *dipentene.* The oil also contains small quantities of polyterpenes and oxygenated compounds, and it is known that the proportions of these bodies in oil of elemi vary considerably *according to the botanical origin of the Elemi resin.*

Oil of Elemi distilled from Elemi resin by Messrs. Schimmel has been examined by Wallich, who found it to have a sp. gr. of 0·900 and to be dextro-rotatory. The examination showed it to contain considerable quantities of a dextrogyre phellandrene, whilst in the portion boiling between 175° and 180° C. there is so large a quantity of dipentene that the oil would appear suited for the preparation of dipentene compounds. In addition, there was found a large quantity of constituents having higher boiling points, and the amyrin of the resin appeared to be represented in the oil.

Pure Elemi is recognisable by the following specially distinctive tests :—

1.—Soluble in chloroform and ether, the latter solution not being rendered turbid by alcohol.

2.—Only partially soluble in alcohol, and the filtered solution is not precipitated by alcoholic plumbic acetate (1 in 10).

3.—A portion of the alcoholic solution evaporated leaves a residue insoluble in boiling sodium carbonate.

4.—The alcoholic and chloroform solutions are coloured violet respectively by alcohol saturated with dry hydrochloric acid gas and by bromine in chloroform (1 in 20). (Muter).

* Comptes Rendus, xii., p. 184.

Phellandrene, $C_{10}H_{16}$ (above referred to), was first discovered in the essential oil of "Water Fennel," *Phellandrium aquaticum*, of which it forms the principal constituent. In much smaller quantity it occurs also in ordinary Fennel oil from *Fœniculum officinale*, together with *pinene* and *dipentene*, but *anethol* is the principal constituent.

In Elemi oil, phellandrene and dipentene constitute the main components. The phellandrene in both Elemi and Fennel oils is dextro-rotatory, whilst that found in Australian eucalyptus oils, notably *E. amygdalina*, of which it forms the principal part, is lævo-rotatory.

It also occurs in the oils of *Curcuma longa*, *Piper nigrum*, and the oils of the root and seed of *Angelica Archangelica*. Possibly it exists in other oils, the terpene constituents of which have not been examined for it. Phellandrene and terpinene are characterized by the formation of a crystalline nitrite, $C_{10}H_{16}N_2O_3$, when acted upon by nitrous acid, a reaction which is not known to occur with any of the other hydrocarbons, therefore phellandrene can be very readily detected in admixture with the other terpenes by the readiness with which its crystalline nitrosite is formed when a few drops of a concentrated solution of sodium nitrite is added to a glacial acetic acid solution of the terpenes, or to a ligroin solution to which acetic acid is subsequently added. A white voluminous mass of filmy crystals separates almost immediately, but although phellandrene nitrosite is more quickly formed than the terpinene compound, it is not nearly so stable, and can only be re-crystallised with difficulty from a mixture of chloroform and ligroin. When pure the crystals melt at 102° C., and have the opposite rotatory power to the phellandrene from which they have been prepared.*

By the action of dry hydrochloric acid gas, Deville obtained from his specimen of oil of Elemi a solid crystalline substance, $C_{10}H_{16}$ 2 H Cl., but Flückiger failed to obtain from oil of Manilla elemi any such compound; and as further result of his researches, found

* An elaborate study of the terpenes has been made by Wallich, and formed the subject of a lecture delivered before the Chemical Society at Berlin in February 23, 1891, published in the Bericht., xxiv., p. 1525, and abstracted into the London Pharm. Journ. [3], xxii., pp. 270, 350, 553 and 574, 1891. A summary of information on phellandrene and terpinene is also given in "British and Colonial Druggist," xxii., p. 402.

that on fractional distillation the crude oil was separable into six parts; the first five being dextrogyre, but gradually less strongly so, and the fifth portion was lævogyre; the observations were made in a tube of 25 millimetres:—

1	Oil distilling at	172° to 180° C	+ 26°·9
2	„	180° to 183° C	+ 23°·6
3	„	183° to 184°·5 C	+ 21°·2
4	„	184° to 195° C	+ 18°·2
5	„	200° to 230° C	+ 13°·4
6	Thick yellow residue	....	—1°·4

When the crude oil is mixed with concentrated sulphuric acid it thickens and acquires a deep orange colour. On mixing the first fractionated portion with four times its weight of concentrated sulphuric acid, mixing with water and redistilling, the distillate is lævogyre.

A new Elemi has recently been described by J. H. Maiden (Curator of the Technological Museum, Sydney).* The oleo-resin (sample of which was forwarded by Mr. Bailey, Colonial Botanist of Queensland, and analysed by Mr. Mar, Government analyst) is an exudation from the *Canarium Muelleri*, Bailey, a tree which is found in the vicinity of the Johnstone River, Queensland, and is botanically described in the Catalogue of Queensland plants, p. 106, where the following note occurs:—"Upon cutting a log of this tree, Dr. Bancroft observed a flow of honey-like liquid, having a delicious turpentinous odour admixed with lemon, very different to the odour of the official elemi. When digested in cold alcohol the lemon odour is so strongly brought out as to almost bring this substance into the category of a perfume." "The oleo-resin of *Canarium Muelleri* consists of a solution of an amorphous resin in a volatile oil,—the following being the proportions:—

Resin (soluble in alcohol and ether) ...	73·33
Volatile oil	26·67
	100·0

It possesses no particular affinities to Manilla Elemi. No amyrin or other acicular crystals could be detected. There is no fennel odour, as in Manilla Elemi. When exposed to the atmosphere it steadily diminishes in intensity of odour, while the

* Proc. Roy. Soc., Queensland, viii., p. 3.

viscosity increases. After removal of the essential oil by distillation, the residual resin, when cold, is beautifully transparent and of the colour and general appearance of gelatine. The contraction on cooling is great, as the resin cracks in all directions. In other words it is a brittle resin and it therefore powders with great facility, forming an impalpable powder like Sandarach, with the difference that it is far easier to powder than that substance. The melting point of this residual resin is 75° to 76° C."

Bentham and Hooker* give sixteen genera and two doubtful ones, belonging to the *Burseraceæ* and speak of the members of the natural order in general as "*Arbores v. frutices, sæpe elatæ, balsamifluæ v. oleiferæ.*" Lindley speaks of them as "abounding in balsam or resin."

C. Vitiense, Gray, occurs in Fiji.

C. Harveyi, Seeman, occurs in Tonga.

C. edule Hooker fil., is described in Maloney's "Forestry of West Africa" as having "under the bark large masses of scented gum, which is used by the natives in fumigating themselves." The Indian Burseraceæ are dealt with very fully by A. W. Bennett, in the "Flora of British India," and in his "Notes on Indian Burseraceæ"† he goes even more fully into the matter of exudations of trees belonging to this natural order. As regards *Canarium*, Mr. Bennett only refers to the exudations of three species, *commune, strictum* and *Bengalense*. *C. strictum*, Roxb., yields the well-known black Dammar, found in every museum collection; it bears no resemblance to elemi or the product of *C. Muelleri*. *C. Bengalense*, Roxb.‡ exudes a clear, brittle, amber-coloured resin resembling copal. Cooke,§ speaking of **C. commune**, says :—"Commercially, no elemi is derived directly or indirectly from India, and although the tree is found there under the name of 'Java almond,' or 'Junglee badam' (its kernels afford on expression a bland edible oil), its resin seems to be unknown"; Dr. Cooke had charge of the gums and resins in the

* Genera Plantarum, i., p. 321.

† Pharm. Journ. [3], vi., p. 102.

‡ Kurz., "Forest Flora of British India"; also Bennett, *op. cit.*

§ "Gums and Resins of India."

Indian Museum, London, and had special facilities to acquire exact knowledge on the subject. (Bennett states in his "Notes on Indian Burseraceæ" above-referred to, that "This well-known tree, a native of the Malayan Peninsula and Archipelago, is extensively cultivated throughout India.")

Very similar to *C. commune*, of which it may only be a variety, and is scarcely distinguishable except by the shorter stalks to the leaflets, is *C. Zeylanicum*, Blume (Syn. *C. balsamiferum*, Moon; *Amyris Zeylanica*, Retz; *Balsamodendron Zeylanicum* Kunth., in Ann. Nat. Sc. [1]., ii., p. 349; D. C. Prodr. ii., p. 76). This tree is a native of Ceylon.

Angelica.

A. Archangelica (*A. officinalis*), Lin. spec., 360; Oeder, Flora Danica, t. 206; Nees, Plantarum in Horto Medico, ix., t. 14; Hayne, Getrene, Darstellung, vii., t. 8; Woodville Med. Bot. t. 60.

This handsome umbelliferous perennial herb is a native of Europe, on mountains or by river sides, particularly in Lapland, Sweden, Norway, Germany, Carparthian mountains; and from Unalashka to the Bay of Eschsoltz. In Britain it is rare, but apparently a naturalised plant, being principally found on the banks of rivers, lakes and ditches, also in marshes growing among reeds. It is commercially cultivated in Thuringia and on the Erz Mountains of Saxony, but not in sufficient quantity to supply the increased demand of the last year or two, as evidenced by the very important rise in the price of the roots and seeds.

In appearance, it is a stately plant of about 6 feet in height, with a robust, polished stem, striated, most frequently tinged with purple and covered with a glaucous bloom like that of a plum; much branched in the upper part, bearing large compound leaves covered with a bloom like that of the stem. The leaves are at first ternate, then pinnate; leaflets ovate-lanceolate or subcordate, cut, and sharply serrated, partly decurrent, the odd one deeply 3-lobed. The plant may be distinguished at a considerable distance by the large egg-shaped expansions of the leaf-stalks, which serve as an integument for the as yet unexpanded flowers. The involucres consist of a very few linear leaves or are wanting altogether. At the extremity of each branch is a large convex umbel of greenish flowers.

The plant delights in moist situations, or the banks of running water, but it will grow freely in any soil or exposure. The plants are raised from seed in beds 4½ feet wide, to be transplanted; an ounce of seed will be sufficient to sow 12 feet of such beds. The seed should be sown at the end of August, or as soon as it is ripe, as the plants will come up earlier and stronger than when sown in the spring. When the young plants are 4 to 6 inches high they can be transplanted into rows 2 feet apart. They will soon strike root and advance quickly in strong growth. In the second year these strong, erect, branchy stalks will be several feet high, producing large umbels of flowers and seed. In the second year, if the seed is not wanted, the plants should be cut down in May, and the stock will send out side shoots; by repeating this process every year the same plant may be long continued.

The Angelica was formerly cultivated on account of its aromatic leaf stalks, which were blanched and eaten as celery; now they are candied and preserved in syrup by confectioners; for this purpose the young shoots of the stem and stalks of the leaves are the useful parts, and should be cut while green and tender, in May or June.

All parts of the plant *(Angelica Archangelica)* are strongly and pleasantly aromatic; the part most in demand is the fresh root, the essential oil of which is distilled in a large way, principally in Germany. The yield from the Thuringian root is 0·75 per cent., and from the Saxony root 1 per cent. The sp. gr. of this oil is 0·860 at 10° C., 0·858 at 15° C., and 0·853 at 20° C. (Schimmel). The presence in essential oil of angelica root of various unidentified terpenes ($C_{10}H_{16}$) was established in 1882 by Beilstein and Wiegand*: also by Naudin.† Messrs. Schimmel & Co. have now ascertained the presence of *Phellandrene* in the constituents boiling at 170° C. (see Elemi). These constituents on being fractionated readily gave, with nitrate of sodium and glacial acetic acid, large quantities of a solid nitrite, the identity of which with phellandrene nitrite was established by the determination of the melting-point of the repeatedly re-crystallised substance. The chloroformic solution of the nitrite twisted the ray of polarised light to the left. As the rotation of phellandrene is known to be

* Ber. Deutsch. Chem. Ges., 1882, p. 1741.

† Ibid., 1883, p. 1382.

the reverse of that of the nitrite prepared from it, the hydrocarbon contained in Angelica root is thus shown to be *Dextro-Phellandrene.* The seeds of the plant yield 1·15 per cent. of essential oil; the presence of Phellandrene has also been proved in this oil. The oil is largely used in flavouring liqueurs, and to some extent in perfumery.

The following eight species of Angelica are known to occur in Japan: *A. anomala,* Pallas; *A. dahurica,* Benth. and Hook; *A. decursiva,* Miq.; *A, florenti,* Fr. and Pav.; *A. niaequalis,* Maxim; *A. kiusiana,* Maxim; *A. refracta,* Fr. Schmidt. (Jap. *Senkiyu*); *A. sylvestris,* Lin. (?). Some of these roots have been examined by Messrs. Schimmel, who report* that they have the same tufted form as the German, but are lighter and nearly white, and are provided with stronger rootlets. The *A. anomala,* which is cultivated in the open fields in Japan under the name of *Biyakushi,* proved to be very poor in essential oil, the yield being only one-tenth per cent., the oil also being essentially different from commercial angelica oil. Whilst the German distillate has a sp. gr. of 0·853 at 20° C., that of the Japanese is 0·912 at the same temperature. At 10° C. it gives a separation of crystals, and at 0° it solidifies to a paste. The crystalline mass obtained by cooling and draining had the properties of a fatty acid melting at 62°–63° C. The oil boils between 170° and 310° C., the last portion that passes over having a beautiful blue-green colour. The residue solidifies upon cooling, and consists principally of the non-volatile fatty acid. The odour of the oil is unusually intense and persistent, more acrid than that of the German angelica oil, but possessing the characteristic suggestion of *musk.* In the succeeding Bericht. of the same firm it is stated that information has been received from Mr. Murai, of Tokio, that the *Angelica anomala,* Pallas (Syn. *Angelica Japonica,* J. Gray, Jap. *Biyakushi*), above referred to, is cultivated in Japan on account of its roots. Mr. Murai's experience as to the oil contents of the root corresponds with that of Messrs. Schimmel. From roots cultivated at the Botanical station in Tokio he obtained 0·074 per cent., and from seed 0·67 per cent. The oil was of a greenish colour, and had a strong odour resembling that of *musk.*

* Bericht., April, 1889.

A. atropurpuria, Hoffmann (Plantarum umbelliferarum genera, p. 169), is considered to possess the same properties as *A. officinalis.* It is a native of the American Continent from Canada to Virginia, in moist meadows. It is described by Bigelow in his Flor. Bostoniensis, p. 68; also in Cornuti's Canadensium Plantarum, p. 199, and in Monet de la Marck's Encyclopédie Méthodique, i., p. 173.

The **Angelica sylvestris,** Lin., sp. 361, native of Europe, Siberia and the Caucasus, and of frequent occurrence in England,* is less grateful in odour and more bitter in flavour than A. Archangelica.

An oil very suggestive of the odour of oil of Angelica is the oil distilled from the Persian Gum Ammoniacum of commerce. The yield is about 0·3 per cent. of a dark yellow oil having a sp. gr. of 0·891 at 15°, and boiling between 250° and 290° C. (Schimmel).

As above observed, the odour of musk is noticeable in Angelica; the plant contains free angelic acid; the root of Sumbul, a plant belonging to the same natural order, has a very pronounced odour of musk, and contains 9 per cent. of a balsamic resin, which, when brought into contact with water, develops a musky odour; a solution of potash converts this resin into a salt of potassium (sumbulate or sumbuollate of potassium) and sets free *sumbulamic acid* smelling very strongly of musk. It has been long since affirmed (Ricker and Reinsch, 1848) that this last acid, contained in Sumbul root to the extent of about ¾ per cent., is simply *Angelic acid*, which, in angelica root is accompanied by a little valerianic acid.

Angelic acid $C_5 H_8 O_2$ may be prepared from oil of chamomile as follows:—100 grams of oil of chamomile are vigorously shaken with 51 grams of caustic potash, dissolved in an equal weight of water until the whole forms a crystalline magma. After standing for 24 hours, this is shaken with as little water as possible, when the alcohols which have been set free form a light layer and are separated. The aqueous salt solution is decomposed by sulphuric acid, extracted with ether, and the ether distilled off. The residual oil quickly solidifies and is then freed from adhering liquid on the filter-pump, well pressed between filter paper and distilled. The

* Smith, Eng. Bot., t. 1128; Woodville, Sup., t. 265.

acid passes over at 185° C., and may be further purified by recrystallisation from ether.*

Angelic acid is difficultly soluble in cold, but readily soluble in hot water, and crystallises in long monoclinic prisms which have an aromatic odour and melt at 45°-46° C. It boils at 185° C., and when boiled for some time or when heated with sulphuric acid to 100° C. is converted into *Tiglic acid*, with which it is geometrically isomeric; both having the same constitutional formula. Tiglic acid is found along with angelic acid in Roman oil of cumin. This remarkable instance of geometrical isomerism has been investigated by Professor Wislicenus of Leipzig and Professor Fittig of Strasburgh.†

Toddalia.

Toddalia. An essential oil, which is considered to resemble in odour a mixture of Basilicum and Lemon grass, is distilled from the leaves of the *Toddalia aculeata* Pers.‡ Syn. *Paullinia Asiatica*, Lin., Spec. 524; *Scopolea aculcata* Smith, a rutaceous shrub very widely dispersed through Asia and extending as far south as Mauritius. It is a shrub of moderate size, with weak or flexnose branches usually armed with small recurved prickles, and bearing trifoliolate leaves composed of oblong or oval-oblong leaflets, the leafstalks and also the midribs of the leaflets being generally prickly. On the Malabar Coast the plant is called *Kaka-Toddali*. On the Nilgiri Hills it is locally known as "Wild orange tree." Its flowers are white, and, being very strongly scented, could doubtless be utilised in perfumery.

Three varieties of the shrub are known, viz.:—

Var α, acanthophylla (D. C. Prod., ii., p. 83), racemes shorter than the leaves; leaves prickly; leaflets ovate-lanceolate. Native of Malabar. Rheede Mal., v., t. 41.

Var β, nitida (Lam. ill., t. 139, f. 1), racemes longer than the leaves; leaflets ovate, unarmed. Native of Ceylon. Burm. Zeyl., p. 28, t. 24.

Var γ, rubricaulis (Willd. in Rœmer et Schultes Systema Vegetabilium, v.. p. 323) branches pubescent, leaves

* Ann. Chem. Pharm., ccl., p. 242.

† Ibid, cclxxii., p. 99.

‡ Persoon Synopsis Plantarum, p. 249.

unarmed; leaflets obovate, acuminated. Native of the East Indies.

Messrs. Schimmel & Co. examined a sample of oil from the leaves of *T. aculeata*, supplied by Mr. Hooper (Quinologist to the Government of Madras), and report on it as follows (Bericht., April, 1893):—"The oil is of thin consistency and pleasant odour, resembling at once that of Lemon-grass and Basilicum. Examination showed it to contain considerable proportions of citronella-aldehyde (citronellone), and along with this it contains an alcoholic principle which boils at over 200° C. A closer examination was rendered impossible through want of material."

Other species of *Toddalia* are:—

T. angustifolia (Lam. ill., No. 2759). Branches unarmed, pubescent; leaflets linear-lanceolate, shining, veined beneath; racemes lateral, shorter than the leaves. Flowers white. Native of the Mauritius and the East Indies.

T. Megapotamica (*Scopolia Megapotamica*, Spreng, Syst., app. p. 91). Unarmed; leaflets lanceolate, abruptly acuminated, quite entire, opaque, smooth; panicles, axillary, divaricating. Flowers white. Native of Brazil, at Rio Grande.

T. Venosa (*Scopolia venosa*, Spreng, Syst. app., p. 91). Leaflets spatulately lanceolate, quite smooth, shining above, veined beneath; branches warted; branchlets smooth; racemes axillary. Native of Brazil, at Rio Grande.

An oil with a peculiar pleasant odour, reminding of lemon, is distilled from the crushed fruit of **Xanthoxylon piperitum** D.C., "Japan Pepper," called in Japanese "Sansho." This fruit forms part of the powdered mixture of seven spices known in Japan as "Nana iro tôgarashi," which, literally interpreted, signifies "seven sorts of cayenne pepper." The other ingredients are cayenne pepper, orange peel, sesame seeds, black pepper, poppy and hemp seeds.

The essential oil was prepared and examined by Stenhouse in 1857, who confined his work to the determination of a terpene boiling at 162° C. (*Xanthoxylene*) and a crystalline body, $C_{10}H_6O_4$, to which he gave the name *Xanthoxylin*. More recent investiga-

tions made by Messrs. Schimmel* result in finding the yield of essential oil to be 3·16 per cent., the sp. gr., 0·973 and boiling point between 160° and 230° C.

Mint.

The *Menthæ* are herbaceous labiate plants belonging to a genus whose numerous species are widely distributed over the world. As general characters of the genus, the flowers occur in dense whorls arranged in terminal or axillary heads or spikes. The calyx is 5-toothed, usually regular; the corolla bell-shaped, with a short tube and a nearly regular 4-lobed limb, and the stamens are four, erect, of equal size. Great difficulty exists in discriminating the species, owing to the capacity for variation possessed by these plants, but the cultivated species remain constant, as the plants are harvested before the seed matures, and are propagated abundantly by suckers or by division of the running roots.

The most important of the mints, commercially, are the "Peppermints," which are cultivated on a large scale for the sake of the volatile oil.

Peppermint is distinguished in appearance from Spearmint by its purple tint, by the leaves being stalked and by the terminal spike-like inflorescence being obtuse.

Botanically known as *Mentha piperita* (Lin., Spec. 805), it has been frequently figured:—Bentley and Trimen, Med. Plant., t. 203; Smith, Eng. Bot., t. 687; Woodville, Med. Bot., t. 169: Zorn, Icones Plantarum Medicinalum, t. 56; Petiver, Herbarii Britannici catalogus, t. 31; Ray, Synopsis stirpium botanicarum, t. 10, f. 2; Sole, Menthœ Britannicæ, t. 7.

The occurrence of "peppermint" in England was first noticed in Hertfordshire and this name was given to it by Ray in his "Historia Plantarum," published in 1704. Its commercial history dates from about the year 1750, when its cultivation was commenced in a very small way at Mitcham in Surrey. Fifty years later, the amount under cultivation was about 500 acres, and the industry reached its zenith in about 1850, just one hundred years after its introduction, when the area cultivated was about 500

* Bericht, Oct., 1890.

acres, but owing to successful American competition, this industry in England began to wane. In England, the principal districts in which it is still cultivated are Mitcham and Carshalton in Surrey, Market-Deeping in Lincolnshire, Hitchin in Hertfordshire and Wisbeach in Cambridgeshire.

In England, two varieties of the plant are grown called the "black" and the "white" mints. There are few botanical characteristics by which these two varieties can be distinguished, except that the former is much the coarser plant, its stems are more tinged with purple, and the upper surface of its leaves are of a more purplish-brown. It flowers somewhat later. The oil it affords is more abundant, but is more rank and less valued than that of the "white." The stems of the "white" mint are green and its leaves are rather more coarsely serrated than those of the "black" variety. It is less hardy than the "black" mint, it does not so well withstand the spring frosts or prolonged droughts. In some plantations both varieties are grown, and mixed together in the still, the result being improved in flavour by the superior delicacy of the oil of the "white" variety, but in some districts the "black" alone is used. A Mitcham grower states the "black" mint to yield 30 lb. of oil per acre and the "white" 24 lbs.

The conditions under which peppermint arrives at perfection are: a temperate or moist warm climate, and a rich, somewhat sandy soil, with abundance of moisture; but if grown on a heavy or clay soil, which holds the moisture, or a poor chalky, or gravelly soil, the result is disappointing. The land should be well ploughed as late in the year as possible, and either cross-ploughed or thoroughly pulverised in some other manner. Early in the spring the land should be laid off in furrows 24 to 26 inches apart, and "sets" or portions of the roots of old plants are to be thickly placed in the furrows and covered lightly. These sets grow vigorously the first year and throw out numerous stolons above the surface of the ground; hence, in the autumn the first crop has always to be cut by hand with a sickle to prevent injury to the stolons. After the crop has been removed, these are allowed to harden, or become woody, and then farmyard manure is scattered over the field and ploughed in. In this way the stolons are divided into numerous portions and covered with soil. If the autumn proves wet, the stolons do not harden, but may become sodden and rot if the soil be at all heavy; but if the weather and

soil be favourable, the plants retain their vitality, and the field is lightly top-dressed in the spring with Peruvian guano. In fresh ground the plant requires hand-weeding two or three times, as the hoe cannot be used without injury to the roots and stolons of the plants. If the weather is very wet in August, and the soil too heavy for the excess of moisture to pass freely down, the leaves of the plants are apt to drop off and leave the stems almost bare. It is said that if a rope be run over the plants, one man walking along one furrow and another along the nearest one, so as to remove excessive moisture from the herbage, the rust may be to a great extent prevented from spreading.

The gathering of the herb for distillation commences about the beginning or middle of August and lasts for some weeks, the stills being kept at work night and day. The time for gathering is judged by the opening of the flower spikes. In fine sunshiny weather, the flowers take about a fortnight to become fully expanded.

The herb of the second and third year (for the same plants rarely yield a fourth crop on the same land) is cut with scythes and then raked by women into loose heaps ready for carting. A group of boys then follow and glean the stems which have escaped the scythe, and add what they collect to the heaps. The herb is then carted to the stillery. In the Lincolnshire plantations there are several stills of 7 or 8 feet in height and 5 feet in diameter, holding about 5 cwts. each of herb. A perforated false bottom, fitted with a large hook in the centre, rests in it about 2 feet from the bottom of the still and enough water is poured in to cover the false bottom about 2 feet. The still is then filled up with the herb, which is trodden in by men. The lid is then placed on and fastened down with two transverse bars. As the lid fits into a water-joint, any excess of temperature and pressure is at once noticed by the water being jerked out of the water-joint. Direct heat is applied instead of superheated steam, and the oil is distilled at as low a temperature as possible. The distillation is continued for about four-and-a-half hours (by reason of the irrational method of conducting the operation); the lid is then removed, and a rope being attached to the hook on the false bottom, the whole of the herb is raised bodily out of the still by means of a windlass and is taken away to the fields in the empty carts on their return journey. The spent herb is then left in heaps in the corner of the fields, and

after being allowed to rot, is mixed with farmyard manure, then distributed over the fields and ploughed in.

The yield of oil varies considerably according to the weather, being much larger in proportion to the quantity of plant when the summer has been dry. The average yield is stated above. The oil, on keeping, much improves in mellowness, even if stored for so long a period as ten or fourteen years. The English oil commands by far the highest price, but the acreage under cultivation is comparatively small to that in America and in Japan. The English oil is frequently adulterated with American and Japanese oil to such an extent as to be no longer recognisable.

Distillation of oil of peppermint was first accomplished in America by a Mr. Burnett in the year 1816, in the County of Wayne, State of New York, who collected on the banks of a little stream sufficient wild plants to produce about 40 pounds of the oil. In the year 1835 the industry was established in Michigan, in St. Joseph's County, on White Pigeon Prairie, about two miles north of a village of that name, a distillery being erected the following year. Up to this time, and for ten years later, the distilling apparatus used was very crude. Distillation by diffusion of steam through the plants was commenced ih 1846, and is the system now in use.

The principal peppermint plantations in America are now in Wayne County, New York State, and in the State of Michigan. It is also grown in a few Counties in Ohio and in some parts of Canada (Ontario). At different times the magnitude of the business and the limited area within which it was carried on, led to extensive speculations. At one time the production of the entire Wayne County was controlled by a single firm, who contracted with the large growers to discontinue the cultivation of mint for five years.

There are now under cultivation of peppermint in Wayne County 1076 acres of old plants

and 1119 ,, of new ,,

2195 acres.

Calculating the yield of one-year-old plants at 24 lbs., and of two-year-old plants at 8 lbs. per acre, the probable yield of 1893 may be estimated as follows :—

1076 acres	at 8 lbs	per acre	...	8608 lbs.
1119 „	24 „	„	...	26856 „
				35,464 lbs.

which is a considerably smaller yield than in former years. The causes of this falling-off are that the area planted this year is considerably smaller than that of any of the three preceding years, by reason of the unfavourable climatic conditions which prevailed during the planting period; also heavy rains and ravages of insects, such as wire-worms and grasshoppers have seriously damaged both the old and the new plants in the peppermint plantations. The grasshopper pest was so severe that it was necessary to cut the first herb a week before its proper time. The average crop of the preceding five years, 1888-92 was 51,400. Michigan oil is not generally so much esteemed as Wayne County (N.Y.) oil, because a great deal of it is brought to market dementholised.

The English crop of 1893 was so severely damaged by the abnormal drought that the yield of the first cutting was only one half of the average.

The American method of cultivation has been described by a grower as follows :—"In early spring the ground, having been ploughed, is marked out in furrows 2½ feet apart. In these furrows are placed the roots and runners which have multiplied from the setting the preceding year. One acre of good roots usually furnishes sufficient to set from 5 to 10 acres of new ground. These roots and runners are from one-eighth to one-fourth of an inch in diameter and from 1 to 3 feet in length when in a healthy state. In setting, they are carried in large sacks, strung over the shoulders of the workmen, who place them in rows so that there shall be one or two living roots or runners at every point in the row. While placing the roots with their hands, they at the same time cover them with their feet. It is quite an interesting sight, owing to the queer motions of the workmen, to see these roots planted. A good, experienced workman, in mellow ground, with good roots, can set about one acre per day. The young plants appear above the ground about two weeks after setting, and are carefully kept clear of weeds until August, when, if the season is fair, the plants have thrown out such a quantity of runners as to render further weeding very difficult."

Of course the crop of the first year's growth is more free from weeds than during the subsequent years and the oil is correspondingly purer. The weed which causes most trouble in America is the *Erechtites hieracifolia*, Raf., known as "broom-weed," "mares-tail," "fire-weed," &c., a composite plant yielding a volatile oil which is bitter and pungent, and by its presence impairs the naturally fresh, penetrating and delicious taste of the pure oil of peppermint.

Another weed which gives almost as much trouble is the *Erigeron canadense*, Lin.*

In England also the presence of weeds in the plantations causes considerable damage to the quality of the oil. Some cultivators make an extra payment to their workmen during the harvest for separating out the weeds. A grower has been known to be obliged to abandon his peppermint plantation by reason of the impossibility of eradicating the *Mentha arvensis* ("corn-mint") which had invaded it, and which, as it was impossible to separate out from the crop, ruined the fine flavour of the peppermint.†

Several other weeds are injurious in this respect, particularly the "Ground Ivy" (*Nepeta glechoma*, Syn. *Glechoma hederacea*,

* Sowerby, Eng. Bot., t. 2019.

† *M. arvensis* (Lin. Spec. 806) is a native of Europe, and plentiful in Britain. It is very common in shady places by the sides of ditches, in bogs, and all moist soils. Its stem is beset with retrograde pili or villi, or in some varieties is nearly glabrous. The leaves are petiolate, ovate or oblong, rounded at the base, cuneated or narrowed, the floral ones all conforming to the cauline ones, exceeding the flowers. The whorls are all globose, many-flowered, remote; bractes lanceolate-subulate, about equal in length to the tubular or campanulate calyces. Corollas red or purplish. Stamens sometimes exserted, but usually enclosed. In *M. arvensis var. vulgaris* (Benth. Lab., p. 179), the calyx is campanulate and villous; the pedicels glabrous; the stem and leaves villous. For figure, see Sole, Menth. Brit., t. 12; Smith in Trans. Lin. Soc., v., p. 213; Sowerby, Eng. Bot., t. 2119; Reichenbach, Iconographia botanica, p. 24, t. 968, 970, 971, 972 and 973. Supposed to be identical with *M. agrestis*, Sole, Menth. Brit., t. 14, and Sowerby, Eng. Bot., t. 2120; also with *M. Austriaca*, Jacquin, Floræ Austriacæ icones, v., p. 14, t. 430, and Allioni, Flora Pedemontana, i., p. 18, t. 75, f. 2. There are many other varieties of the "Corn-field Mint," or "Wild Mint," but, as an eminent botanist has remarked, the European mints (as is generally the case with plants which are very common in highly civilized and long cultivated countries, especially aquatic plants), vary much in appearance, and the repeated attempts by different authors in different countries to reduce these inconstant and ephemeral variations to so many species, have thrown so much confusion into this difficult genus that it is now almost impossible to clear up the chaos thus produced.

Willd.), (Sowerby, Eng. Bot. t. 853), a small trailing herb of very rapid growth and very difficult to exterminate. Its odour is powerful and offensive.

In America the mint is cut with a sickle, scythe, two-fingered cradle, or mowing-machine according to the option or carefulness of the cultivator. It is then allowed to wilt in the sun for five or six hours and is then raked into heaps and allowed to remain a short time before being distilled. (It is thought that by this process, a larger yield of oil is obtained and its colour improved, but it is difficult to believe this, because there must be loss by evaporation, loss of the most volatile and finest part of the oil, and the effect of sweating the herb in heaps would be a distinct alteration in the character of the oil by reason of fermentation and oxidation.)

Not every cultivator is provided with a still, but such appliances are found distributed about the region at accessible distances. Some are of the most primitive character, and others are constructed more elaborately. The apparatus and method differ from that employed in Europe. The still consists of a wooden tub or vat of heavy staves hooped with iron, and of a size to correspond with the amount of steam furnished by a boiler. Many of the vats are 4 to 5 feet in diameter and 8 to 10 feet deep. The wilted mint is packed into the vat by treading with the feet until the vat is full, when a cover, made steam-tight with rubber packing is fastened down with screw-clamps. A steam-pipe connects the lower part of the vat with a boiler, and another pipe from the centre of the cover connects the vat with the condensing worm. The latter varies in size according to the capacity of the still, but becomes progressively smaller towards the outlet. The worm is so placed as to have a constant stream of cold running water surrounding it. The steam from the boiler being admitted to the vat at a pressure of 30 to 40 pounds, the oil of the mint is volatilized, and mixed with the steam it is condensed in the worm and received in a separating vessel in the usual way. In many instances the receiver is made of tin. The aqueous distillate is not at every distillery redistilled with a fresh charge of herb, so doubtless much oil held in suspension and in solution is wasted. The yield of oil from American plantations is estimated at from 10 to 30 pounds per acre, the young plants yielding the most, but much depends on the weather during the early months of the

season, the growth being much prejudiced by drought; the old plants particularly require for their development a large amount of moisture in early Spring.

The oil is packed in tin cans or glass demijohns, holding about 20 pounds each. From the oil thus produced, the refiners and exporters make their selections, and upon their judgment in selecting, skill in refining, and their honesty, as well as the care used in excluding foreign plants from the crop, depends the quality of the American oil found in the market. It is very probable that most of the adulteration which the oil undergoes, takes place after it has left the hands of the original distillers and refiners.

Next to Wayne County, New York State, the largest peppermint producing locality in the United States, is St. Joseph County in Michigan. Nearly every farmer thereabout now raises some peppermint, but usually in connection with other crops, while a few devote their whole time to its cultivation. Each owner of a distillery on the average distils the crops of ten other growers with his own, for which he makes a charge of 25 cents per pound of oil obtained. One farm about eight miles south-east of Three Rivers contains about 900 acres, of which 400 acres are put into mint each year and alternated with clover to keep up the strength of the soil. The owner of this farm, Mr. Hall, has four large distilleries, capable of producing a total of some five hundred pounds of oil per day. The largest still-house is situated in the centre of a 600-acre field; it contains four stills, and is surrounded with mint fields as far as the eye can see. The distillatory apparatus here in use differs from that in general use in America only as regards the condenser, which, instead of being in a coil, is in longitudinal sections about 14 feet long, which lap under each other, the top about 6 inches in diameter and tapering to some 2 inches at the bottom or outlet, and is made of tin. The cooler consists of a tin trough about 8 inches in diameter with perforated bottom, the length of the condenser, over which it sets; and through the perforations a constant stream of water is kept flowing over the tin condensers. When fresh herb is distilled, it requires generally an hour to obtain all the oil, but if it has been partially dried, thirty minutes will suffice to accomplish the purpose. It is also observed that the dried plants will pack much more closely in the vats than the green ones, allowing of a greater quantity to be distilled at one charge, and those distillers who consider that no

loss in quality and quantity of the oil is incurred by drying the plants, avail themselves of this economy, but in the opinion of others it is a false economy, as the character of the oil is changed. In the fairly dried condition the herb will have lost 49 or 50 per cent. in weight;* and as it is estimated there are about 15,000 tons of it annually harvested in America, the settlement of this question of drying is of material interest both to distillers and growers, saving the former greatly in cost of manufacture, and the latter in cost of transport. The opinion of a French writer on this subject† may be summarised as follows:—"Although in England the mint is generally distilled in the green state, it is left in small heaps on the ground for several days before being put into the still. This practice requires much caution, as the cut herb thus heaped up soon becomes heated, and even if it be admitted that the commencement of a slight fermentation augments the quantity of oil and is even beneficial to its quality, an excess of heat destroys it completely. Opinion in France is much divided as to the comparative results of distillation in the green or the dried state, some observers maintaining that the recently distilled oil from the dried plant is sweeter than that from the green plant, and does not possess the unpleasant herby taste ("goût de vert") or the fiery taste ("goût de feu") which are usually observed in distillates from fresh herbs." The author of the work here quoted, bases his opinion in favour of the "dry" system, on the supposition that during the desiccating process, the tissues of the plant undergo a sort of fermentation or reaction which completes their maturity in the same manner as certain fruits only attain their perfection of flavour and aroma by keeping them for a certain length of time after being gathered. He further argues that the essential oil is more easily extracted from the vessels which contain it, when the plant is dry than when it is green, and that in this last-named condition the prolonged action of boiling water or steam necessary to thoroughly extract it, also imparts to it the unpleasant "green" or "herby" flavour. Whether these opinions are correct or not, it is certain that the less this oil (or any oil) is subjected to the action

* It appears to lose on complete desiccation 75 per cent. of moisture unless further oil is generated during the process of drying, as Messrs. Schimmel found the fresh herb to yield 0·3 per cent. and the dried 1·25 per cent. of oil.

† M. L. Roze, "La Menthe Poivrée, sa culture en France, ses produits, etc., Paris, 1868, chez Baillière et fils.

of heat, the finer and more natural in odour and flavour it will be. The English process of distillation with water, in stills of primitive construction, is too slow, the product being injured by the formation of empyreumatic products and partially decomposed by the prolonged action of heat, the stills being too deep in proportion to their width. The American method, although rapid, is injurious to the oil, as too much heat is developed by the steam at the pressure above indicated. The attention of buyers should be directed to the oil distilled in Germany, a country in which the most careful attention is given to *all* essential oils.

Peppermint is also very largely distilled in Japan and to some extent in China. Specimens of these plants have been obtained and carefully examined by Mr. Holmes,* who found them to possess the botanical characters of *Mentha arvensis*, as defined in De Candolle's "Prodromus;" the leaves being stalked, ovate-lanceolate, and the hairs on the stems and pedicels reflexed, those of the calyx being erecto-patent, and those of the upper surface of the leaf appressed, the calyx being bell-shaped with acute lanceolate or narrowly-triangular teeth. The Chinese plant differs from the Japanese one, in the leaves being narrower in proportion to their length and in the calyx teeth being shorter and more broadly triangular. In outline, the leaves of both plants taper more to the base and have a longer petiole than the English forms of *M. arvensis*, coming very near to *M. Canadensis* in this feature. The latter plant, however, has spreading hairs on the stem. Mr. Holmes remarks, in recapitulation of his elaborate study of this subject that, "for convenience, the name of *Mentha arvensis var. piperascens* should be retained for the Japanese peppermint plant and that of *Mentha arvensis var. glabrata* for the Chinese one."

The total production of Peppermint oil in Japan in 1892 has been estimated at about 50,000 pounds weight. The export of crude menthol from Japan in 1891, amounted to 22,017 pounds.

The yield of the 1893 crop is estimated at 30,000 catties or 40,000 of normal oil, consisting half of menthol crystals and half of liquid oil.

The Japanese peppermint plant has proved to be perfectly hardy in England, having been grown at Colchester, and there produced seed.†

* Pharm. Journ. [3], xiii., p. 381.

† Gardeners' Chronicle, 21st May, 1887.

German Peppermint oil. Plantations of peppermint have recently been established at Miltitz, in the vicinity of Leipzig, by Messrs. Schimmel & Co., who state that they have selected a particularly fine and valuable kind of the herb for cultivation, and that the distillation is effected by improved methods, using fresh and carefully picked leaves. The oil is of the same type as the best English article, very powerful and without bitter after-taste, and is characterised by its great solubility, caused by the low proportion of terpenes present. This oil is packed in original half-kilo bottles with a special label. Thus, it is at length possible to procure peppermint oil in a state of purity.

A small quantity of peppermint is also produced in France, at Sens, in the Département of the Yonne, and it has been grown very successfully at Auzin in the Département du Nord, the soil of which district, although sandy and producing a less vigorous growth of the plant than does richer and moister soil, yet developes a more delicate aroma in this oil and in that of other aromatic labiate plants. M. Hanart, the proprietor of the plantations of aromatic herbs in this district, carries on the manufacture of oil of peppermint to a considerable extent, and his land produces annually between three and four tons of peppermint herb per acre, yielding about 18 pounds of oil per acre. In this district the crop is cut earlier than in England, and before the flower appears. It is made up into little cocks and left on the field several days; then, after all admixture of other herbs has been removed, the entire plants are packed into the stills, which are of about 60 gallons capacity, and heated by steam jackets or spirals. The distillation is carried on as rapidly as possible, in order not to acquire a herbaceous taste. The oil is of pale greenish yellow and of very agreeable odour. It is then purified by several washings with cold water, and exposed to the air during some weeks in a cool, dark place. After this it is rectified and then kept in bottles secluded from light and air for some years before being sent to market. The oil of peppermint so prepared is alleged to successfully rival the finest English oil in quality.

The northernmost part in which peppermint and spearmint are cultivated is Norway.

Peppermint oil owes its value to the solid compound termed *menthol*, $C_{10}H_{20}O$, or *Menthyl alcohol* (frequently expressed $C_{10}H_{19}OH$). Gaubius, in the year 1771, was the first to observe

that the oil extracted from the plants near Utrecht deposited crystals of *Camphora Europea Menthæ Piperitides.** The Japanese and Chinese oils contain this substance in much larger quantities than either the English or the American oils, and frequently occur in the form of a crystalline mass saturated with liquid hydrocarbons.

This peppermint camphor was mistaken for ordinary camphor until Dumas† and Blanchard Sell‡ detemined its composition, and Walter§ fixed its molecular formula by a determination of its vapour density, which was found to be 5·62. It was first proved by demonstration to be an alcohol by Oppenheim‖ by the formation of several compound ethers, and it has been shown by Beckett and Alder Wright¶ to be connected both with the paraffin series and the benzene series, inasmuch as by the action of dehydrating agents (decomposition by heating with phosphorus pentachloride or zinc chloride) it is easily converted into *menthene*, $C_{10}H_{18}$, a dextro-rotatory liquid, which smells like cymene, boils at 167°, and, by the action of bromine, combines to form tetrabromdecane, which is converted into cymene by heating and distilling the product with sodium.

Menthol, when purified by repeated crystallisation, forms into large prisms which have somewhat the appearance of magnesium sulphate. It remains solid at ordinary temperatures, melts at 42°·2 C.,** boils at 212° C., and is lævo-rotatory. Commercial menthols melt at from 37°·7 to 42°·2 C., the melting point depending on the freedom of the menthol from the hydrocarbon constituents of the essential oil; a very small percentage of such hydrocarbons lowering the melting point considerably. It has been shown by Trimble†† that the presence of a very small quantity of hydrocarbon is sufficient to hold the menthol in solution and prevent it from crystallising out, but if these hydrocarbons,

* Flückiger, "Pharmakognosie," p. 686.

† Ann. Chem. Pharm., vi., p. 252.

‡ Ibid., vi., p. 293.

§ Ibid., xxxii., p. 288.

‖ Ibid., cxx., p. 350, and cxxx., p. 176; Comptes rendus, liii., p. 379 and 483, and Jahresbericht der Chemie, 1861, p. 683; Journ. Chem. Soc., xv., p. 24.

¶ Year Book of Pharmacy, 1875, p. 605.

** Beckett & Wright, Journ. Chem. Soc., 1876, i., p. 1.

†† Pharmaceutical Record, 1885, pp. 291 and 312.

consisting of about five per cent. of the oil, are removed by fractional distillation under reduced pressure, the menthol can be crystallised out from the heavy portion remaining, by submitting it to a temperature of about —10° C. The solidification is accelerated by dropping a few crystals of menthol into the liquid when the thermometer marks the point of congelation.

The liquid portion of Mitcham peppermint oil, has been found* to consist simply of isomeric and polymeric terpenes, having an odour entirely distinct from peppermint, somewhat reminding of lemon oil, though corresponding more nearly to that of freshly distilled turpentine oil.

If the light oil and the menthol be both fractionated off from the crude oil, there will be found in the still a resinous mass, almost free from odour. This appears to be partly formed during the process of distillation, and amounts to about 10 per cent. of the original oil.

The liquid portion of Japanese peppermint oil has been found by Beckett & Wright† to contain a small amount of a substance isomeric with borneol.

Menthol is very soluble in alcohol, ethers, chloroform, carbon-disulphide and most oils, but is more soluble in oil of peppermint than in any other. It has a sp. gr. of 0·890 and small particles gyrate on the surface of water like camphor. Several compounds of menthol have been obtained, the acetate, formed by heating menthol with glacial acetic acid, being a light, oil-like body without colour. By substituting butyric for acetic acid, butyrate of menthol is obtained.

The variety of menthol obtained in Michigan from the oil of *Mentha piperita*, is termed "pipmenthol," in order to distinguish it from the Japanese article. It has a distinct odour of peppermint; Japanese menthol has that odour but slightly.

Menthol has been used by the Japanese for about 200 years, and is known by them as "Hakka-ne-sei" or "Hakka-no-Hari." Previous to the late change in the social system of Japan, the native gentlemen were accustomed to carry attached to their girdle a medicine-box, which contained, among other things, a com-

* Flückiger & Power, in a paper read at the British Pharmaceutical Conference, August, 1880.

† Journ. Chem. Soc., 1876, p. 3.

pound called "Hotan," of which menthol was one of the principal ingredients. The Chinese peppermint oil is sold in small bottles under the name of "Po-ho-yo."

Peppermint is known in Kwang-tung by the following characters :—

薄荷葉 The Leaf, or Dried Herb.

薄荷冰 Menthol.

薄荷油 Peppermint Oil.

It is only within recent years that the value of menthol has been recognised by Western nations. The *Lancet* drew attention to it in 1879, and since that period many medical men, both in Europe and America, have published their experiences of it as a remedy for such diseases as headache, neuralgia, toothache, epidemic influenza, etc. So popular has this specific become that at the present day by far the largest proportion of the menthol produced is employed in the manufacture of menthol cones, which are made use of as a household remedy for nervous diseases such as those mentioned.

Menthol intended for the manufacture of cones must be without a trace of oil of peppermint, as the smallest percentage of this latter lowers the melting point so much as to render it quite unsuitable for this purpose.

Menthol cones are made in the same way as suppositories, the menthol being first fused and then poured into metal moulds. The fixing of the cones in the wooden cases is accomplished by simply heating the proper end of the cone in a small flame in the same way as sealing-wax is heated, and quickly placing it in the recess. Wooden cases are preferable to those made of metal, the latter, owing to the property metal possesses of being a good conductor, being apt to get heated in warm weather: the result is that the menthol which touches the metal melts, and the cone becomes

quite loose. The different menthol cones which have been produced commercially, may be classed under five heads:—

1. Cones prepared from pure menthol, that is, menthol having a melting point of 42°·2 C. The characteristics of these cones are that they are hard, and when scraped with the finger-nail feel gritty and stone-like. When rubbed on the skin they are susceptible of a high polish. The cone is completely soluble in alcohol and a small piece heated in a test-tube melts very readily.

2. Cones that have been prepared with menthol that has not been completely freed from oil of peppermint. These are recognised by their comparatively strong odour of peppermint and by their melting point being under 42°·2 C.

3. Cones made of wax, stearin, cetaceum, or paraffin, with varying proportions of menthol. The menthol used in this class has not, as a rule, been freed from oil of peppermint. These, when scraped with the finger-nail, have not the stone-like grit characteristic of the first class, but feel soft and yielding, and small pieces readily peel off. When a small portion is heated in a test-tube, a little is melted from the outside, and the remainder floats in the liquid thus formed, at the same time slowly dissolving. A fragment placed in cold alcohol does not dissolve; if the cone has a larger percentage of menthol than wax, etc., the edge of the fragment becomes fringed, owing to the menthol dissolving out and leaving the wax which was disseminated throughout the cone as a framework; but if the wax be in excess the alcohol has no visible effect. If the alcohol be heated the fragment liquifies; the menthol dissolves in the alcohol, and the wax solidifies on cooling. The proportions of both may in this way be determined.

4. Cones consisting of menthol, with the addition of some powder as an adulterant. These are recognised by simply rubbing them on the skin, when they impart a feeling as if the latter were being rubbed with pumice-stone soap. This is owing to the menthol dissolving out and leaving the grains of insoluble powder sticking on the cone like the pumice-stone in the soap.

5. Cones which may belong to any of the above classes, but which contain in addition a small percentage of eucalyptol, thymol, benzoic acid, or other irritant. The distinguishable feature of this class is the intense prickling sensation experienced when

the cone is applied to the skin, which presently assumes a bright scarlet appearance, the irritating effect produced by these substances being quite distinct from the cooling sensation imparted by menthol.

The action of menthol depends on its rapid and complete evaporation from the skin, but when a cone adulterated with greasy matter is used, the grease retards, if it does not actually prevent, this evaporation, and thus causes the menthol to act as an irritant. Pure menthol cones slowly evaporate on exposure to the air; in cones made partly of fatty matters this tendency is greatly checked. When any powder has been used to adulterate the menthol, it is seen as a coating on the outside of the cone after the latter has been exposed for a few days, the non volatile powder having been left behind after the menthol had evaporated.

It is clear therefore, that only the purest menthol is suitable for the preparation of cones, and that no admixture of any kind ought to be employed in their manufacture.

The following are regarded as reliable tests for the purity of menthol* :—

1. It should be completely and readily soluble in twice its weight of chloroform. On the addition of a small quantity of iodine to this solution, a rich indigo-blue colour (not dark-green) ought to be imparted, and this colour should be completely discharged on shaking the mixture with solution of caustic potash or soda.

2. The melting-point ought to be 42°·2 C. (108° F.) and the boiling point not lower than 212° C. (413°·6 F.) and there should be no residue on evaporation.

3. Menthol shaken with an oxidising mixture, such as sulphuric acid and bichromate of potash, ought to be entirely converted after prolonged heating into a dark green flocculous substance (menthene).

4. Strong sulphuric acid ought not in the cold to blacken menthol to any considerable extent.

5. When menthol is heated with a small quantity of anhydrous-zinc chloride, the mixture ought to give off the odour of menthene.

* Read before the Harwich Pharmaceutical and Chemical Association, 10th February, 1885, by G. C. Waldie, New York.

6. Strong caustic potash solution has no action on pure menthol.

The sp. gr. of English oil of peppermint is recorded by Messrs. Schimmel* as being 0·905 at 10° C., 0·900 at 15° C., and 0·898 at 20° C.; and that of the American 0·906, 0·903 and 0·901 at the same respective temperatures.†

Investigations made by Mr. A. M. Todd, a large distiller of oil of peppermint in Michigan, resulted in slightly different figures. In a paper read by him at a meeting of the American Pharmaceutical Association in 1886 he states:—"The difficulty which scientific men seem to have experienced in establishing accurate tests for the purity of essential oils has been that they could not conveniently obtain the plants from which they themselves could distil the specimens used in their investigations; and, while undoubtedly every possible precaution was taken, the result shows that they have in many instances operated upon impure samples, and although pure specimens undoubtedly were in some instances received, yet they had in many cases no positive knowledge, *per se*, which were pure and which were impure; hence too great a range of differences has been allowed in physical characteristics and chemical reactions.‡

In correspondence with some well-known chemists, they gave it as their opinion that a wide range of specific gravity, &c., might

* Bericht, April, 1887.

† The age of these samples tested is not stated, neither is it stated if any resin originally contained in them had been rectified out before testing. At a meeting of the British Pharmaceutical Conference held 24th August, 1880, it was pointed out by Mr. Umney that crude Mitcham oil of peppermint always contains a large amount of resinous principle, and its presence is owing to the rough way in which the oil is manufactured, parts of the charge of plant in the still being charred; thus empyreumatic matter is driven over, and a large quantity of resinous matter is consequently present in the oil. He considered that no specimen of English manufacture could be considered pure unless it had been rectified with water, and even then a very small quantity of the resinous principle would be present.

‡ In the discussion on a paper "on the Constituents of Peppermint oil" by Professor Flükiger and Dr. Power, read at a meeting of the British Pharmaceutical Conference in August, 1880, it was observed by a Member of the Conference that investigation showed "that adulteration varied over a large number of specimens, and it was difficult to determine what could be relied upon unless the experimentor were present and saw the oil made, or made it himself. It seemed as difficult to obtain pure peppermint oil as genuine port wine, which, it was said, could only be secured by going to Portugal and buying a cask, and then sitting on it all the way home."

result from oil and climate. On account of this I took greater pains to verify my determinations by testing samples grown under much varying conditions of soil and climate, both in Europe and America. Forty-three samples were examined, including oils produced in St. Joseph, Wayne, Ionia, Hillside and Kalkaska Counties, Michigan, Wayne County, New York and vicinity (all of which were produced from American roots long acclimatised); also one specimen grown in America from roots imported from England, and one specimen grown and distilled in England. The sp. gr. has been variously stated in Dispensatories and other standard works at from 0·840 to 0·950 at 60° F. But there were none of the samples which were pure which had a sp. gr. below 0·910 at 60° F., except the two last mentioned, grown from English roots; the one grown in America being 0·9085, the one distilled in England being 0·9088. Nor were any specimens of pure oil found having the sp. gr. above 0·917 which were in a perfectly soluble condition. One sample distilled by myself in 1875, and consequently eleven years old, had, on account of its age, a sp. gr. of 0·924; one sample from New York 0·933, and another from the same district 0·940. However, these three samples were found to be not readily soluble; the latter sample, when submitted to rectification, being found to contain 9 per cent. of insoluble resin. Of five samples imported from Europe, but one was found pure; two from Germany were found to contain dementholized oil of *Mentha arvensis*; one from London, which bore a fraudulent and forged label (as Michigan oil of peppermint, manufactured at Evart, Michigan County, U.S.), had the sp. gr. 0·899. This oil, when submitted to fractional distillation, was found to contain 50 per cent. oil of turpentine, and no Michigan peppermint whatever. The sample imported from London as "German oil of peppermint" consisted chiefly of Pennyroyal and *Mentha arvensis*. Allowing a slightly wider range of difference than was really intended, it is evident that whether from English or American plants, pure oil of peppermint is never below 0·908 sp. gr., nor, when fresh and soluble, above 0·917 sp. gr., so that the difference formerly allowable, that is, from 0·840 to 0·950, is reduced to one-tenth."

Respecting the tests for purity of (English and American) oil of peppermint, Mr. Todd, in the paper above referred to, states:— "Oil of peppermint, when freshly distilled, or when two or three

years of age, if kept in well-filled vessels, should dissolve readily in alcohol in all proportions, making a clear solution without need of filtration.*

When a few drops of the oil are placed upon white paper and held over a lamp or gas jet, it should volatilize quickly and perfectly without undergoing change or leaving any residue. When 3 drops of the oil are placed upon 4 grains of resublimed iodine (or such quantity as will thoroughly saturate, but not drown the iodine), there should be but a slight reaction, and what little vapour is produced should be almost invisible, becoming entirely so after having arisen about twelve inches above the mixture, the colour of the vapour assuming a bluish cast. The colour of the mixture in this test should be carefully noticed, which, in the case of pure peppermint, is of a brown, or brownish-black colour, the iodine dissolving slowly and imperfectly. If oil of turpentine, erigeron, "Fire-weed," or other terebinthinate oils are present, there will be quite a violent reaction (according to the quantity of the adulterant) with the evolution of considerable heat, and a red or reddish-yellow vapour will be produced, of a rank odour, partaking considerably of the nature of the adulterant, and the mixture will change to a bright violet. If the colour of the mixture is most carefully noted, a very slight quantity of such adulterants can be detected. When to 25 drops of alcohol, 1 drop of nitric acid, sp. gr. 1·2, is added, and then one drop of pure oil of peppermint, there will be produced, within about half an hour, a blue or bluish-green colour, which will remain permanent for a long time.

Oil of pennyroyal and of *Mentha arvensis* produce no coloration. A much more intense coloration will be produced when one drop of nitric acid, of the strength as stated, is mixed with 50 or 60

* This test would appear to apply only to the English oil, at all events with any degree of reliability. The "Hotchkiss" oil, which is the most esteemed brand in the Wayne County, was formerly perfectly soluble in rectified spirit, 56 o. p. one part to seven, but consumers have since found that spirit of even 60 o. p. only makes a milky solution, which no kind or extent of paper filtering will clear. Such a mixture, when first made, and for a considerable time after, is unsaleable; but in the course of four or five months it partially loses its turbidity, and becomes comparatively clear, depositing on the sides and bottom of the vessel in which it is made a dirty precipitate. This precipitate is of a resinous nature. It has been recommended to clear the milkiness from the solution, to add a little carbonate of magnesia, shake occasionally for a few days, then filter.

drops of the essential oil, without alcohol. Some specimens of oil of peppermint imported from Germany and England showed by this test a mixture with *Mentha arvensis*. To make this test valuable, however, samples of known purity should be first operated upon, and note taken of the depth of coloration required for a pure oil. Another test for the detection of pennyroyal, which also indicates *Mentha arvensis* when in sufficient quantity, is the following:—Take 1 drachm each of chloral hydrate and pure sulphuric acid, adding 12 drops of alcohol. When this solution is mixed with a like quantity of pure oil of peppermint, a dark cherry colour is quickly produced and maintained for a long time. Pennyroyal (or oil of peppermint heavily adulterated with this oil) gives no such colour, being more of a yellowish cast, and changing to an olive-green. With *Mentha arvensis*, a yellowish-brown colour is produced which is maintained for ten or twelve hours, and thirty-six hours later, has a slight tendency to assume a cherry colour or one intermediate between the cherry and the brown. It was noticed that when the true oil of peppermint was mixed in equal proportions with that of *Mentha arvensis*, a deficiency in the intensity of the cherry colour was plainly observable."

The colour reactions produced by acids on oil of peppermint were noticed by Professor Flückiger in 1871*; he found that 50 to 70 drops of oil of peppermint shaken with one drop of nitric acid sp. gr. 1·2, turn faintly yellowish, brownish, and after an hour or two exhibit a most beautiful blue-violet, or greenish-blue colour when examined in transparent light. When observed in reflected light, the liquid is of a copper colour and not transparent. If this is warmed, the green or blue coloration takes place speedily; it may also be immediately provoked by adding a greater amount of nitric acid, say 1 drop to 19, or nine drops of the essential oil. The colour is remarkable on account of its persistency, for it lasts a week or two at least in cold. He adds that "unfortunately this reaction cannot be applied as a true test, as an admixture of 5 per cent. of oil of turpentine does not at all prevent peppermint oil from assuming the blue or green colour. . . . Carvene, the more volatile portion of carraway oil, also acquires a slight similar fluorescence, but by no means comparable to the above-described as regards purity and intensity of colour. Peppermint oil which

* Pharm. Journ. [3], i., p. 682.

has become coloured in this way is quickly decolorized if shaken with calcium carbonate; granulated zinc likewise causes it to turn brownish. Spectroscopic examination of the coloured oil furnishes no phenomena of peculiar interest. Chromic acid dissolved in chloroform does not perform the same reaction as nitric acid." The professor discovered, a few months later,* that Japanese and Chinese oil of peppermint does not partake of this reaction at all; it is not coloured by nitric acid (sp. gr. 1·20) even when gently warmed with it.

It has been remarked by Dr. Polenske, technical assistant to the German Imperial Health Department, that peppermint oil which had stood for some time in sunlight lost the power of giving colour reactions with acids. This observation is of particular practical importance.

The Dutch Pharmacopœia requires as a test for the identity of peppermint oil that a mixture of 5 drops with 20 drops of glacial acetic acid shall gradually develope a dark blue colour, with a copper-coloured fluorescence.

It has been remarked by Messrs. Schimmel & Co. that the formation of the colouring compound was dependent on a process of oxidation, and did not occur when air was excluded. If a small bottle is completely filled with the mixture of peppermint oil and glacial acetic acid and closed with a cork, the liquid becomes a scarcely perceptible blue, which, however, does not deepen in intensity even when the mixture is allowed to stand for days. If, however, the bottle is opened and the air thus enters, the mixture gradually darkens in colour, and by reflected light shews a beautiful copper-coloured fluorescence. It should be mentioned that a certain time is necessary for the reaction to clearly develop, and that hours often elapse before the fluorescence has attained its maximum. Japanese peppermint, of which various samples were examined, either gives no colour reaction at all, or only to a very slight extent.

Commercial oil of peppermint is usually adulterated to the extent of 30 per cent. at least. The yellow resinous oil sold under the name of "American" or "Crude oil of peppermint" consists chiefly of oil of turpentine, and on evaporation leaves a residuum

* Pharm. Journ. [3], ii., p. 321.

† Bericht, October, 1890.

of pure resin; of course by applying the iodine test, such oil will explode at once. Mitcham oil is nearly colourless, sometimes however, it has a natural very pale greenish tinge, which is often imitated by the addition of chlorophyl. Old, dark-coloured oils are commonly bleached by exposure to the light, to the probable destruction of a portion of their other properties.

During a trial which took place in Wayne County, concerning fraudulent oil of peppermint, it was shown that the oil had not only been deprived of its menthol, but had been largely adulterated with oil of camphor. The removal of the menthol may be detected by first fractionating off the light oil, then subjecting the residue to a low temperature (about — 12° F.), when the menthol should freeze out. It can also be ascertained by the aid of the polariscope, menthol being strongly lævogyre, and oil of camphor dextrogyre to about an equal degree.

Large quantities of American oil of peppermint have frequently been imported into Canada which were found on examination to be adulterated with castor oil and alcohol. On one occasion a parcel of 55lb. was submitted to distillation; 18lbs. of oil of peppermint of good quality were separated from the distillate and the residue in the still, weighing 21lbs., was found to be castor oil. The difference between the sum of these two weights and the original quantity represented the amount of alcohol present. A mixture of these constituents in the above proportions yielded a clear and presentable oil, strongly resembling the genuine article. Its density was slightly lower (·894 at 60° F.), its reactions with iodine were precisely similar, and it dissolved perfectly in rectified spirit. The presence of the fixed oil may, however, be detected by the characteristic stain it leaves upon paper, and that of the alcohol by agitation with an equal volume of water, when a milky emulsion will be produced.

Menthone, $C_{10} H_{18} O$. This Ketone is formed by heating menthol with sulphuric acid and potassium bichromate.* It is a mobile liquid which smells of peppermint and boils at 206° C. When its solution in petroleum is heated with sodium, and a current of carbon dioxide passed through the mixture, the product yields menthol on decomposition with water. The latter substance

* Moriya, Journ. Chem. Soc., 1881, p. 77.

therefore bears the same relation to menthone as borneol to camphor.*

Menthyl chloride, $C_{10}H_{19}Cl$. was obtained by Walter by the action of phosphorus pentachloride on menthol, while Oppenheim prepared it by heating with hydrochloric acid. It is also formed by the combination of menthene with hydrochloric acid, and is a liquid which has a pleasant odour *resembling that of mace,* and a refreshing taste. It boils with decomposition at 204° C.

A mint possessing a very sweet and delicate odour of peppermint is the **Mentha pulegium var. Gibraltarica.** It is cultivated

MENTHA PULEGIUM,

var. Gibraltarica ad nat., from a plant grown in England. Natural size, and showing leaf and flower magnified.

in many English flower-gardens as a border plant or for "carpet bedding" on account of its pale, bright-green colour, and its close, neat habit of growth. As this plant is not quite sufficiently hardy to withstand the English winter if left in the open ground, it is usual to preserve a stock in cold frames. It will bear rapid forcing in the early spring, and seems to revel in strong heat and moisture. It is one of the very easiest plants to propagate, so much so that it is hardly necessary to talk about taking cuttings, as its growth

* Atkinson and Yoshida, Journ. Chem. Soc., 1882, p. 49.

hugs the soil and throws out roots at every joint, so that little plants can be continually cut off.

A very sweet odour and taste of peppermint is developed in *Ziziphora tenuior*, Lin., which see.

The "Small Peppermint Thyme" is *Thymus piperella*, Lin., which see. It is very nearly allied to the following:—

Micromeria Piperella, Benth. Lab., p. 379, or "Small peppermint Micromeria." *Micromeria* is a genus of *Labiatæ* numbering about sixty species, which are spread over nearly all the temperate and warmer parts of the globe, but occur in greatest abundance in the Mediterranean region. They are erect or prostrate branching perennial herbs, with opposite leaves and axillary whorls of small purple or white 2-lipped flowers, or the flowers are gathered in spikes at the ends of the twigs. Some of the species have an odour like common thyme, others smell like some kinds of mint. They are chiefly recognised by the tubular 13 to 15-ribbed and 5-toothed calyx, which is not distinctly 2-lipped as in thymus. *M. piperella* is suffruticose, with ascending pubescent branches; leaves sessile, broad-ovate, obtuse, rounded or sub-cordate at the base, glabrous on both surfaces; upper leaves oblong, small; fascicles of flowers loose, pedunculate, secund, few-flowered; bractes small, oblong; calyces nearly sessile, pubescent, with subulate teeth, the 3 superior teeth spreading; throat naked inside. Native of the south of Europe, as of Piedmont and Croatia. Syn. *Thymus piperella*, Allioni Flora Pedemontana, i., p. 21, t. 37, f. 3 (bad figure); Waldstein et Kitaibel, Descriptiones et Icones plantarum rariorum Hungariæ, ii., p. 169, t. 156; *Thymus Croaticus*, Persoon, Synopsis plantarum, ii., p. 130; *Calamintha Croatica*, Host, Flora Austriaca, ii., p. 132.

The odour of peppermint has been observed in the fraction of oil of *Barosma betulina*, boiling between 205° and 210° C. (see Buchu).

Mentha viridis, Lin., "Spear-mint" or "Garden Mint." This is the plant which is used for culinary purposes under the name of "Mint" (Bentley & Trimen, Med. plant., t. 202; Sole, Menth. Brit., t. 5; Sowerby, Eng. Bot., t. 2424. Figured as *M. verticillata* by Feuillée, Journal des observationes physiques, etc., pp. 42 t. 28. It has an erect stem; leaves nearly sessile, ovate-lanceolate,

unequally serrated, and are, as well as the stems, glabrous; floral leaves all bractea-formed, rather longer than the whorls, and are, as well as the calyces, hairy, or sometimes glabrous; spikes cylindrical, loose; whorls approximate, or the lower ones are distant. This plant is a native of the temperate parts of Europe. It is found at the Cape of Good Hope and in North and South America, but was probably carried thither from Europe. Two varieties are described by Bentham,* the *angustifolia* with narrow leaves and the *crispa* with curled leaves.

The oil of spearmint of commerce is chiefly derived from *Mentha aquatica, var. crispa,* Benth.,† Syn. *M. crispa,* Lin. Spec., p. 805. The leaves of this variety are plicately curled, lacerately toothed and on short petioles. It is figured by Nees in his "Plantarum in horto Medico." Other varieties of *M. aquatica* are the *nemorosa* (Syn. *M. citrata* Reichenbach) "Iconographia botanica," t. 977; *hirsuta,* Hooker's "Continuation of Curtis' Flora Londinensis" v., t. 166, and *subspicata* (Syn. M. *palustris plicata,* Reichenbach) Iconographia bot., t. 976. The yield of oil from spearmint averages 1 per cent., or nearly 25 pounds weight of oil per acre per annum. Over 100 acres of it were formerly cultivated in Wayne County, New York State, but owing to the low prices which have ruled in this article for many years, the cultivation in America has been totally neglected, and has been limited this year to little more than garden culture, the total area of spearmint in the whole of Wayne County not exceeding 20 acres, representing an output of 400 lbs. as compared with 568 lbs. in 1892; 1,101 lbs. in 1891, and 2,229 lbs. in 1890.

Oil of spearmint has been examined by Trimble,‡ and the result of his investigations appears to confirm those made by Gladstone as far back as 1864,§ viz., that the pure crude oil consists of a terpene $C_{10}H_{16}$ and carvol $C_{10}H_{14}O$, which can be separated by fractional distillation, and by precipitating carvol by means of alcoholic ammonium sulphide. The result is a mass of beautiful acicular crystals, readily purified by solution and recrystallisation from hot alcohol, and, when pure, free from odour, composed of

* Labiatum Genera and Species, p. 174.

† Ibid., p. 177.

‡ Pharmaceutical Record, 1885, pp. 291 and 312.

§ Journ. Chem. Soc.

$(C_{10} H_{14} O)_2 H_2 S$. This compound decomposed by ammonia yields carvol, which has an odour resembling spearmint, although distinct from it. With the exception of the odour this carvol appears to be identical with that from the oils of carraway, dill and nutmeg. Oil of peppermint (after fractionating off the light portion) does not precipitate menthol when treated with alcoholic ammonium sulphide. After distilling off the second fraction from oil of spearmint, consisting largely of carvol, there remains in the still (whether the operation has been conducted by direct heat or by forcing steam through the oil), a thick dark brown resinous substance, almost free from the odour of spearmint. It is thought probable that a portion of this resin is a natural constituent of both spearmint and peppermint oils, and that the quantity is increased during the process of distillation by partial decomposition of the oil.

Bergamot Mint, *Mentha odorata*, Sole, Menth. Brit., t. 9; Sowerby, Eng. Bot., t. 1025; Smith, in Trans. Linn. Soc., v., p. 192. Syn. *M. adspersa*, Willd. Spec., iii., p. 79; *M. citrata*, Ehrhart, Beitrage sur naturkunde, vii., p. 150. This has long been known to gardeners as "orange," or "bergamot" mint. The herb often assumes a purple colour. The corolla is handsome, and more of a reddish hue than in most mints. As a rule it is perfectly destitute of hairs. The smoothness of its flower-stalks and calyx are constant in every soil and situation. It is a native of England and is frequently found in watery places in Cheshire, in North Wales, and near Bedford. Its perfume has been likened to that of Bergamot, or of *Monarda didyma*.

Monarda is a genus of herbaceous plants belonging to the labiate order and distinguished by their ringent corolla, the upper lip of which is very narrow and conceals the two anthers. The leaves are downy and variously notched, and the flowers, which grow in whorls and heads, are made conspicuous by their coloured bractes. All species are natives of North America.

M. didyma, called "Oswego Tea" from the use sometimes made of its leaves in America, bears bright scarlet flowers and bractes; its leaves emit a very grateful, refreshing odour somewhat resembling a mixture of "Bergamot Mint" and some species of

Salvia. For figure of the plant see Bot. Mag., t. 546; Miller's Figures of Plants, described in the Gardeners' Dic., t. 183, f. 1; Trew, Plantæ selectæ ab ehret pietæ, t. 66.

M. Fistulosa, the "Wild Bergamot," has narrower leaves than *M. didyma,* and smaller purple, pink, and white flowers, never scarlet. It is also a much taller plant, often attaining a height of 5 feet. It is very common on the West coast of North America and Canada, extending southward through Texas into Mexico, where it has been found near Jalapa. It is figured in Reichenbach's Iconographia botanica exotica, ii., p. 28, t. 172; Miller's Figures, t. 183, f. 2 (compare with *M. didyma,* above. This species is very variable in downiness and in size and colour of flowers and bractes. A variety of *M. fistulosa* is figured in Curtis' Bot. Mag., t. 145, which has been thought a variety of *M. didyma. M. fistulosa var. mollis* is figured in Bot. Mag., t. 2958, approximating to *M. menthæfolia* Graham in the Edinburgh Philosophical Journal, xxi. (1829), p. 347. See also Reichenbach Icon. exot., ii., p. 28, t. 171, and t. 3310 in Bot. Mag. of *M. fistulosa,* which, by Beck, in Silliman's American Journal of Science, x., p. 260, is taken as a distinct species, *M. Bradburyiana,* found near St. Louis and in uncultivated places along the Missouri and Ohio.

Other distinct species of *Monarda* are:—

M. Russelliana; native of the Arkansas and among the Rocky Mountains; figured in Bot. Mag., t. 2513; Hooker's Exotic Flora, ii., t. 130; Sweet's British Flower Garden, ii., t. 166.

M. punctata, Lin. Spec., p. 32. "American Horse Mint";* native from Virginia and New Jersey to Florida, Carolina and New Orleans, Bot. Rep., t. 546; Bot. Reg., t. 85; Bentley and Trimen, Med. Plant., t. 208. This perennial plant is 1 foot to 1½ feet in height; clothed with fine pubescence. Its leaves attain 2 inches in length; they are sparingly toothed or entire, petiolate, lanceolate, narrowed at the base; floral leaves and outer bractes sessile, coloured a little at the base. Calyces pubescent, having the throat shortly bearded and the teeth nearly equal, lanceolate, short and stiff. Corolla yellowish, dotted with brown, glabrous; tube hardly exserted; lower lip dotted.

* In England, *Mentha Sylvestris* is known by the name of "Horsemint."

The essential oil of *Monarda punctata*, one of the known species of thymol, has been the subject of an investigation in the chemical laboratory of the Philadelphia College of Pharmacy.* The oil distilled from the leaves and tops of the herb is described as having a yellowish or brownish-red colour, being lighter than water, and crystallising below 5° C. It is reported to contain about 50 per cent. of a previously unexamined $C_{10}H_{16}$ hydrocarbon, about 25 per cent. of thymol, higher oxygenated compounds, including $C_{10}H_{18}O$, also formic, acetic and butyric acids. It is added that the thymol occurs in the freshly distilled oil in a non-crystallisable condition, but by age it becomes crystalline, and separates with any perceptible change in chemical composition.

M. Aristata, Benth. Lab., p. 318; native of Arkansas, Texas (at Béjar), Rio de la Trinidad, &c.

M. Purpurea. Bot. Cab., t. 1396.

All species of *Monarda* are of easy culture and propagation, growing freely in any soil, and are readily increased by dividing at the root.

Balm, or Melissa. The generic name is derived from μελισσα, a bee and μελε honey, indicative of the attraction the flowers have for the insects on account of the honey they produce. The different species are widely diffused, having representatives in Europe, Central Asia and North America. **Melissa officinalis**, Lin. Spec. 827. Common Balm. Woodville, Med. Bot., t. 147; Sabbati, Hortus Romanus, iii., t. 61; De Lobel, Stirpium Icones, t. 277. Native of Portugal, Spain, South of France, Italy, Sicily, Greece, about Aleppo, Tauria, Iberia, and Caucasus. The plant is herbaceous, 2 to 4 feet in height, erect, branched; leaves half to 3 inches long, those of the stems and sterile branches truncate or cordate at the base, upper floral and ramal ones smaller, rounded or cuneated at the base, all obtuse, or the upper ones are acute, more or less villous on both surfaces; whorls axillary, loose, distant; cymes distinct, 3-6 flowered; corolla white or pale yellow, often twice as long as the calyx, but variable. The size and form of the leaves are also variable. The leaves have a pleasant odour, somewhat like lemon mixed with citronella. (The name of the herb in French is *Citronelle*.

* Am. Journ. Pharm., March, 1888, p. 113.

The essential oil is very rarely distilled from the plant alone, lemon peel being put into the still with it; the compound oil thus obtained being used in France as a flavouring ingredient in certain cordials. The leaves and young shoots of the plants were used, in combination with several other aromatics in the preparation of the celebrated "*Eau de Melisse des Carmes.*" In England it is now little used, unless for making a simple balm tea, which affords a grateful diluent drink in fevers, and for forming a light agreeable beverage under the name of "balm wine." Anciently it was generally recommended in hypochondriacal affections, and by Paracelsus promised a complete renovation of man. From the fondness of bees for this plant, it was named *Apiâstrum*, *Melissa*, *Melissophyllum*, and was directed by the ancients, among other herbs, to be rubbed upon the hive to render it agreeable to the swarm.

Melissa grandiflora, Lin., Sp. 827; Bot. Mag., t. 208. Syn. *Thymus grandiflorus* D. C. Flore Française, iii., p. 562. A native of Europe, in shady woods, possesses the same odour in its leaves as the common balm. There is a variety of this with white flowers and another with red flowers, both much inferior in odour to the purple, as is also a variety with variegated leaves.

Calamint, or "**Mountain Balm.**" The name is derived from καλος, beautiful and μινθα mint, in reference to the beauty of the plants and its affinity to *mentha*. *Melissa calamintha*, Lin., Spec., p. 827; Syn. *Thymus calamintha*, Smith, Flora Britannica, p. 641, and Sowerby, Eng. Bot., t. 1676. Native of Central and Southern Europe and Central Asia. In England it occasionally occurs about the borders of fields, hedge banks and road sides, on a gravelly soil, but is seldom found in any quantity together. The plant is from 6 inches to 18 inches in height, perennial, flowering from August to the very end of autumn. Its stems are herbaceous, branches ascending, villous. Leaves usually an inch-and-a-half long, petiolate, broad-ovate, bluntish, serrately crenated, rounded or truncated at the base, green on both surfaces, villous; raceme loose; cymes very loose, subdichotomous, few-flowered; calyx distinctly bilabiate, with subulate teeth; lower teeth elongated; corolla more than twice as long as the calyx. The plant is remarkable for its peculiar sweet and fragrant scent.

Basil Balm, or **Basil Thyme.** *Melissa Acinos*, Benth. Lab., p. 399 (from ακινος the Greek name of a balsamic plant now unknown). This is an herbaceous, pleasantly aromatic annual with erect stem, usually procumbent at the base; branches usually purplish, more or less villous; leaves ovate, sub-serrated; flowers almost sessile; whorls distant, 6-flowered; lips of calyx short; corollas purplish blue, upper lip entire; lower lobe of style flattened. Native of Europe in cornfields. Syn. *Thymus Acinos*, Lin., Spec., 826; Hooker, Continuation of Curtis' Flora Londinensis, i., with a figure; Sowerby, Eng. Bot., t. 411. *Acinos thymoides*, Mœnch, Melhodus plantas horti, p. 407. *Acinos vulgaris*, Persoon, Synopsis Plantarum, ii., p. 131. *Calamintha arvensis*, de la Marck, Flore Française, ii., p. 394; de Lobel, Stirpium Icones, i., t. 506, f. 1; Rivinus, Ordo plantarum flore monopetalo, t. 43, f. 2; Morison, Plantarum historia universalis Oxoniensis, iii., p. 404; sect. ii., t. 18, fig. 1.

Various other, but less important species of Melissa are described by Bentham in his Labiatarum genera et species, and by Linneus in Species Plantarum.

All species of Balm grow in common garden earth and are of easy culture. The perennial herbaceous kinds are readily increased by parting the roots; the suffruticose species by cuttings, and seeds of annual kinds may be set in the open ground.

Cedronella.—The herbaceous, labiate plant sometimes incorrectly designated "Balm of Gilead" is the *Dracocephalum Canariense*, Lin. (Spec., 829), also known as *Cedronella triphylla* and *Cedronella canariensis*, is a native of the Canary Islands. It is sometimes met with in old-fashioned gardens, in the warmest parts of England, and is sometimes cultivated in cool green-houses, being valued for the rich fragrance of its foliage, a fragrance very difficult to describe, but somewhat reminding of lemon leaf and camphor. The usual height of the plant in England is from two to three feet: under favourable conditions of climate and cultivation it will attain five feet. The stalk of the plant is square, tolerably firm, upright, and much branched. The leaves are ternate, and pubescent beneath. The flowers are formed in loose terminal whorls, 10 to 12-flowered; corolla white or pale purple.

The plant is easily propagated both by seeds and cuttings. The finest plants are obtained from seeds brought direct from the

Canaries; the English-grown seed not attaining sufficient development. Strong plants may be raised from cuttings, and these form healthier plants than those raised from English seed.

Leaf of Dracocephalum Canariense, Lin.
(ad. nat.)

In the wild state the plant is found on the shady side of woods, in the light, loose mould, which results from the decay of leaves.

All the green parts of the plant abound in essential oil, but it does not appear that this oil has ever been distilled in any quantity, or in any way examined.

Dracocephalum Moldavicum is an annual of about 15 inches to 18 inches in height, with small blue flowers, which form in whorls in the axils of the upper leaves. The leaves are fragrant, but their fragrance is of a much coarser nature than that of *D. Canariense.*

Buchu.

Buchu Folia, as described by the British Pharmacopæia, are the dried leaves of *Barosma crenulata*, Hook; *Barasma betulina*, Bartling; and *Barosma serratifolia*, Willdenow.

The leaves of these three species are entirely derived from the Cape of Good Hope, the exports from Cape Colony amounting to nearly half a million pounds weight annually.

The name *Barosma* has been applied to this genus of *Rutaceæ* on account cf the heavy, powerful and penetrating odour that the species possess. The genus is botanically characteristic by an equally 5-parted calyx; 5 oblong petals, 10 stamens, of which 5 are sterile and petal-like, alternately with the 5 shorter, fertile stamens; the style of the same length as the petals and the ovary 5-lobed. The species are small evergreen shrubs with opposite or alternate, simple, dotted, leathery leaves, in the axils of which the flowers are placed on stalks. They are all natives of the Cape of Good Hope, where the leaves are used by the Hottentots as a perfume; their principal use in Europe and America is medicinal, —as a stimulant and tonic, and in chronic diseases of the bladder, the active properties probably being dependent on the powerful volatile oil which the leaves contain. The leaves of all the species are smooth, coriaceous, more or less serrate or crenate at their margins, and marked on the edges and especially on their under surface with glands filled with essential oil. They have a dull greyish-green colour, somewhat paler on their under surface.

B. crenulata (Bot. Mag., t. 2413; Loddiges, Bot., Cab., t. 290; Bentley and Trimen, Med. Plant., t. 46; Berg. in Bot. Zeitung, 1853, t. xii., figs. A.-Q.), grows abundantly in stony, hilly valleys in the western parts of Cape Colony, S. Africa, including the neighbourhood of Cape Town itself and the mountains of Stellenbosch and Worcester. It was introduced into England a century ago and was cultivated as an ornamental plant for many years, but does not appear to have perfected seed here; being also difficult to propagate by cuttings it has now almost disappeared. The leaves of this species vary in shape and size in different commercial samples, but are of the kind sometimes distinguished as *ovate-oblong Buchu*.

B. betulina (Lodd. Bot. Cab., t. 404, copied in Stephenson and Churchill, t. 121, and Woodville. Bentley and Trimen Med. Plant., t. 45) grows in mountainous places in the district of Clanwilliam, North of Cape Town, and some other parts of the west of Cape Colony. In its extreme forms it can be readily distinguished from *B. crenulata* by its small rigid cuniate leaves with their blunt re-curved apex and cartilaginous margins set with

A B C D

BUCHU LEAVES.

A.—*Barosma betulina.*
B.—*Barosma crenulata.*
C.—*Empleurum serrulatum.*
D.—*Barosma serratifolia.*

large spreading denticulations, but plants occur which it is difficult to place in either species. The leaves of *B. betulina* are generally less esteemed than those of the other two species here named and are of less commercial value.

The leaves of *B. betulina* are shorter than the other species, and from this circumstance are known in commerce as *short Buchu*, or

from their more usual shape they have been distinguished as *obovate Buchu.* In the British Pharmacopæia they are briefly described as follows:—About three-quarters of an inch long, coriaceous, obovate, with a recurved truncated apex and sharp cartilaginous spreading teeth.

B. serratifolia (Bot. Mag., t. 456; Bentley & Trimen, Med. Plant., t. 47), grows in the districts of George and Swellendam, to the east of Cape Town, in damp situations on the mountain sides. It forms a neater bush than the other species. It is readily distinguished by the shape of its leaves.

The leaves of *Empleurum serrulatum,* Ait., a small shrubby plant of the same Natural Order (Rutaceæ), and inhabiting the same district as *Barosma,* are not unfrequently substituted for the true leaf, and sold as Buchu, but it is much longer and narrower, with the sides parallel, the denticulations coarser, and the apex much more acute; also they are of different odour, and terminate in an acute point without an oil-gland, whereas the leaves of *Barosma serratifolia* are blunt or somewhat truncate, and always provided with an oil-gland at the apex.

The leaves of *B. serratifolia* are not so liable to variation in size and shape as are those of *B. crenulata.* From their length they are known in commerce as *long Buchu.* In the British Pharmacopæia their characters are given as follows:—"From an inch to an inch-and-a-half long, linear-lanceolate, tapering at each end, sharply and finely serrated, 3-nerved." From the shape of the leaves this kind of Buchu is sometimes designated as *linear-lanceolate Buchu.*

The yield of essential oil from *Barosma betulina* has been found by Schimmel & Co. to be 2 per cent.,* "which, even at the normal temperature, was quite filled with crystals of *Diosphenol.*"

The yield from B. serratifolia was 1 per cent., sp. gr., 0·944, which, even during the severe cold of the winter, separated only a very little crystalline Diosphenol, and by treatment with lye only small quantities of this body could be further extracted from it.

The researches of Professor Flückiger on the essential oil of Buchu leaves† resulted, briefly, as follows:—On submitting 35

* Bericht., April, 1891.

† Paper read at British Pharmaceutical Conference, Aug., 1880.

kilos of leaves of *Barosma betulina* to distillation, 180 grams. of essential oil (a little more than ½ per cent.) was obtained. On exposing this oil in thin layers to spontaneous evaporation, crystals of "Barosma camphor" make their appearance. To this substance the name *Diosphenol* has been given, in allusion to "*Diosma*," the original Linnean name bestowed on the Buchu plants.

The crystals can be extracted from the essential oil by means of caustic lye. The oil repeatedly shaken with an equal volume of soda lye, sp. gr. 1·14, forms a yellowish turbid mixture, soon separating into two clear layers (A and B). The heavier layer (A) then displays a bright red colour; it should be washed several times with ether, in order to remove that portion of the oil which is simply dissolved in, but not combined with the alkaline liquid. One volume of the washed portion (A) is then dissolved in four volumes of alcohol, sp. gr. 0·83, and neutralised with an acid, either sulphuric, acetic or carbonic, when an oily layer separates. In a couple of hours, or sooner, it concretes and affords a crystallised mass of diosphenol. The upper lighter layer (B) on being extracted repeatedly with warm water further affords a small amount of diosphenol. The crude oil, as obtained from *Barosma betulina*, yields nearly one-fifth of its weight of the phenol.

A mixture of one volume of alcohol 0·83, and five volumes of ether, is a good solvent for re-crystallising the diosphenol; by gently warming the crude crystals with three times their weight of the mixture, they dissolve, and on cooling afford pure crystals.

The results of two elementary analyses of the crystals were as follows:—

I.—0·2236 gram. of diosphenol gave CO_2: 0·5752 gram. = 0·1569 C and OH_2: 0·1910 gram. = 0·0212 H.

II.—0·2236 gram. of diosphenol gave CO_2: 0·5758 gram. = 0·1570 C and OH_2: 0·1946 gram. = 0·0216 H.

From these figures the formula $C_{14}H_{22}O_3$ may be calculated, thus:—

			Found. I.	Found. II.
14 C	168	70·58	70·17 per cent.	70·21 per cent.
22 H	22	9·24	9·48 ,,	9·69 ,,
3 O	48	20·18		
	238	100·00		*

* This result disagrees with that arrived at by Spica (Amer. Journ. Pharm.,

Diosphenol usually forms acicular crystals; by slow crystallisation somewhat larger, well defined crystals were obtained which were crystallographically examined in Professor Groth's laboratory by Dr. A. Cathrein, and found to belong to the monosymmetrical (monoclinic) system. (A diagram of the form of crystal and measurements of the angles of the faces are given in Pharm. Journ. [3], xi. p. 219).

The crystals of diosphenol melt at 83° C., and boil at 233° C., but cannot be distilled by the usual method without suffering partial decomposition. The solidifying point after fusion is 50° C. By subliming diosphenol in the temperature of a steam-bath, thin prisms, two inches long, are easily to be obtained. It is readily soluble in alcohol of sp. gr. 0·83, less so in ether, but very sparingly in water. The aqueous solution in boiling water on cooling affords small acicular crystals. The solutions are perfectly neutral, and on addition of an alcoholic solution of ferric chloride assume a dark coloration of dingy green. The crude oil, as well as the water distilled from buchu leaves, exhibits the same behaviour.

Diosphenol has a slightly aromatic odour and taste, "*sui generis*," by no means reminding of buchu leaves, but rather of mint. It is soluble in concentrated sulphuric acid, but without forming a crystallisable compound; on saturating the brown solution thus obtained with carbonate of baryum and duly concentrating the filtrate, only a small quantity of uncrystallisable barium salt is obtainable.

Diosphenol is also readily dissolved by caustic lye, but it is not decomposed by the carbonates; by carbonic acid on the other hand, it is precipitated from its solution in potash, soda, or hydroxide of barium. In 50 parts of the latter ($Ba(OH)_2 + 8 OH_2$ in twenty parts of water) diosphenol dissolves very slowly. By allowing such a solution to evaporate slowly over lumps of potash, no well-defined barium compound of diosphenol could be obtained, crystals of the pure phenol even gradually making their appearance on the sides of the beaker. Neither could solid potassium or sodium compounds be prepared. (In the opinion of Professor Flückiger these experiments show that the substance

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Oct., 1886, and Pharm. Journ. [3], xvii., p. 547), who calls this substance an "oxycamphor" of the composition $C_{10} H_{16} O_2$, but he had evidently made a mistake in his figures.

under notice belongs to the class of phenols, although its action on sulphuric acid and the hydroxides of potassium, sodium and barium, is less manifest than with many other substances of the phenol class. Professor Atfield, commenting on this opinion, noticed that Professor Flückiger had used solutions in alkalies, and it was not very easy to get perfectly definite compounds which would stand evaporation by putting carbolic acid into alkaline solutions; but if carbolic acid were mixed with the strong alkali, fusion was effected, and it was quite possible that if this phenol were mixed with its equivalent proportion of solid alkali a compound must be produced.)

As to the other constituents of buchu oil, the portion which had been exhausted with caustic lye was again shaken with the same, when it was entirely dissolved, but immediately separated on addition of much water. This oil, washed with water and dehydrated with powdered chloride of calcium, was distilled. Very little passed until 205° C. (401° F.) was reached. The main portion came over between 205° and 210° C., a small amount only was collected above the latter boiling point. All the various fractions of the oil assumed a green coloration when mixed with aqueous or alcoholic perchloride of iron. The oil boiling between 205° and 210° C, is remarkable on account of its odour, which agrees very nearly with that of *peppermint*. This oil is devoid of rotatory power; submitted to elementary analysis, 0·1942 gram. of it gave CO_2 : 0·5528 gram. = 0·1508 C. and OH_2 : 0·2064 gram. = 0·0229 H., that is to say 77·6 per cent. C. and 11·79 per cent. H. The formula $C_{10}H_{18}O$ requires 77·92 C and 11·69 per cent. H. The main portion of the buchu oil, after the extraction of the phenol, is thus shown to consist of one of the numerous modifications of the molecule $C_{10}H_{18}O$. From some experiments with the crude oil of buchu, instituted by Dr. Power, it would appear that the compound $C_{10}H_{18}O$ is contained in the oil in the form of a compound ether.

Chamomile.

Although of no value as an ingredient in perfumes and flavours, Chamomile yields an essential oil, which is interesting on account of its chemical constitution. The common chamomile is the

Anthemis nobilis, Tragus, a perennial plant indigenous to the South of England, and* was first called "**Roman Chamomile**" by Camerarius. Two kinds of this plant are distinguished (both cultivated in England), the single and the double. The single flowers are usually preferred, on account of their having the largest yellow discs, in which the oil chiefly resides; the single wild chamomile is also preferred for medicinal purposes, as it contains a greater quantity of the bitter principle. The flowers usually found in the shops are the "double" or cultivated sort; in these all or most of the yellow tubular central florets have developed into white strap-shaped ones. These flowers are consequently whiter, larger and more showy, but they are less odoriferous and of less value medicinally. The single variety is apt to become double by cultivation. The cultivation is carried on in England and in Belgium.

English chamomile flowers are said to yield on average, about a half per cent. of essential oil, which, when fresh, is pale blue, but becomes brownish by keeping. Dr. Muter considers that "this oil may be viewed as a mixture of butylic and amylic angelate and valerate. These bodies are easily decomposed by the action of potassium hydrate, forming potassium angelate."

In practice the oil is distilled from the entire plant.

In Germany, the plant known as "**Common chamomile**" is the *Matricaria chamomilla*, "Corn Feverfew," which differs in appearance from "Roman chamomile" in that the flower heads are single, not bitter, and the receptacle is very conical, hollow and devoid of scales. Also its flowers grow on longer stalks, its leaves are more linear and not so numerous.

The oil of chamomile of the shops is generally derived from abroad, and is to a great extent produced from *Matricaria chamomilla* grown in Hungary. It flowers from May to August and sometimes even till October. The flowers, on being bruised, smell somewhat like the true Chamomile, but not so pleasant. The seeds of the *Anthemis* are broad and truncated at the top, wrinkled and of a deep brown colour; those of the *Matricaria* are much smaller, paler, and different in shape. The essential oil of *Matricaia chamomilla* has been found to contain *Caprinic acid*, $C_{10}H_{20}O_2$, which is colourless, smells strongly of chamomile and boils at 150-°

* Sowerby, Eng. Bot., t. 980.

163° C., also *Trichamomillol*, $C_{30} H_{48} O_3$. This last is the deep blue, viscid portion of the distillate; it has a very mild odour, boils at 270°-300° C., and forms a deep indigo-blue vapour.* This body also occurs, together with *absinthol*, $C_{10} H_{16} O$, boiling at 195° C., in the essential oil of wormwood (*Artemisia absinthum*),† in the oil of Pilchurim beans‡ and in the oil obtained by the dry distillation of Galbanum.

The "Common Feverfew," *Matricaria Parthenium*,§ also called *Pryethrum Parthenium* and *Chrysanthemum Parthenium*, is a much stronger plant than the last, the leaves are much more cut and lobed like the oak. Its leaves are of a very bright green. Its flower heads have flat or only slightly convex receptacles and all the florets ligulate. The scales on the receptacle are not membranous. All parts of the plant have a strong unpleasant smell and bitter taste.

Anthemis cotula‖ is a common weed in the South of England, where it is called "Stinking May-weed," on account of its intolerably disagreeable odour. Its leaves differ from those of the true Chamomile (*A. nobilis*) in being quite smooth, not downy. The essential oil contained in the glands with which the surface of this plant is covered causes swelling of the hands of persons employed to pull the plant up as a weed.

Tansy.

Tanacetum vulgare, Woodville, Med. Bot., t. 115. *Tanacetum* is a genus of perennials belonging to the tribe Corymbiferæ, and allied both in characters and properties to *Artemisia*.

T. vulgare, the common Tansy, is an herbaceous plant, native of England, found sometimes in moist pastures and sometimes where the land is very dry, even thriving in a chalky soil. In a deep rich soil it attains a height of nearly two feet, but on calcareous soil is more stunted (and the odour less rank). Its root is

* *Kachler* in Ber. Deutsche. Chem. Ges., iv., p. 36.

† Ann. Chem. Pharm., clxx., p. 290.

‡ Jahresber. Chem., 1853, p. 514.

§ Sowerby, Eng. Bot., t. 1231.

‖ Sowerby, Eng. Bot., t. 1772.

perennial, long, creeping and fibrous; the stem is strong and tough, often reddish, branched towards the top, smooth and bearing many leaves; the leaves are doubly pinnated and deeply serrated. There is a variety with curled leaves (*T. vulgare var. foliis crispis*), which are considered to be even more aromatic than the ordinary sort. The flowers are bright pale yellow and form in terminal corymbs with button-like heads. All parts of the plant are strongly aromatic and on being distilled with water rapidly yield their powerful essential oil. This oil merits a great deal more attention than is now given to it, and might well enter into the composition of toilet vinegars and perfumed salts. The yield is estimated at 0·15 to 0·25 per cent. An excellent test for the purity of this oil is its solubility in 70 per cent. alcohol; thus, an oil of undoubted purity, having a sp. gr. of 0·926 at 15° C., forms a perfectly clear solution with three times its volume of 70 per cent. alcohol. Schimmel & Co. have previously observed the sp. gr. of French oil to be 0·927, and that of German oil 0·930.

It is grown commercially for distillation in Wayne County.

A species now much in demand is *Tanacetum balsamita*, Lin.; having a more mint-like odour; this is generally cultivated in gardens in France.

Oil of Tansy was first investigated to any extent by Bruylants.*

According to this authority it contains an aldehyde $C_{10}H_{16}O$, which, with bisulphite of sodium forms a crystalline compound, and to which he gave the name *Tanacetylhydrine*. Semmler† has investigated this body thoroughly and obtained exceedingly interesting results. He names it *Tanacetone* (a methyl-Ketone), and reports that under a 13 m. m. pressure it boils at 84°·5 C., and that it possesses an optical rotation of $+ 38° \ 30'$ in a 200 m. m. column. Nascent hydrogen (generated from sodium) reduces it to *Tanacetyl-alcohol* $C_{10}H_{18}O$, boiling point 92°·5 C. at 13 m. m. pressure. This latter, like the tanacetone, is a saturated compound. Bromine acts upon it by substitution and not by addition. With hydroxylamine, tanacetone forms an oxime, $C_{10}H_{18}NOH$, which boils at 125°-136° C. With acetic anhydride it does not form a nitrite, but an acetyl derivative. By the action of dilute

* Journ. de Pharm. and de Chim., Nov., 1887, p. 393.

† Ber. Deutsch. Chem. Ges., xxv., pp. 3343, 3352 and 3513.

sulphuric acid in alcoholic solution, *Tanacetoxime* yields a Cymidine

$$C_6H_3\left.\begin{array}{ll} CH_3 & 4 \\ NH_2 & 3 \\ C_3H_7 & 1 \end{array}\right\} \quad \text{which}$$

by oxidation with nitrous acid yields *Carvaerol,* $C_{10}H_{14}O$. By reducing tanacetoxime with sodium, *Tanaeetylamine,* $C_{10}H_{17}NH_2$, is produced, and dry distillation of the hydrochlorate of this base yields *Tanaeetene,* $C_{10}H_{16}$.

According to Semmler, tanacetone also occurs in other essential oils, such as Sage oil (*Salvia offieinalis,* L.), Wormwood oil and Thuja oil (*Thuja oeeidentalis.*)

Another essential oil, resembling in odour that of Tansy, is obtained from **Achillea coronopifolia,** Willdenow,* this is called the Buck's-horn leaved Achillea, an evergreen, herbaceous plant, native of the Levant. This oil is described† as being of a deep blue colour, thin consistency and sp. gr. 0·924 at 15° C.

An oil which in odour strongly resembles that of Tansy, is obtained in Spain from the dried flower racemes and fresh young shoots of **Artemisia Barellieri** and might probably be used as a substitute for oil of wormwood. Its sp. gr. at 15° C. is reported to be 0·923 and its boiling point between 180° and 210° C.

Oil of **Artemisia Hispanica** distilled from young shoots, is considered to resemble Wild Fennel in odour. Both this and the oil of *A. Berellieri* are said to be used in the manufacture of "Algerian Absinthe."

As regards the "Absinthe" business, doubtless the common Wormwood, **Artemisia Absinthium** is a very important ingredient. The plant is found wild in some parts of great Britain, and is here cultivated to a small extent. The main centres of cultivation are the United States, Russia, Algeria, Corsica, and Spain. Preference is given to the Spanish and Algerian oils.

In America the acreage under cultivation of this plant has been considerably reduced. The yield of oil for 1893 is estimated as follows (at the rate of 30 lbs. per acre):—

* Tractatus de Achilleis et Tanaceto, t. i., f. 2.

† Schimmel, Bericht., April, 1893.

Production in Wayne County (N. Y.)	200	lbs.
„ in other parts of the State of New York	200	„
„ in the State of Wisconsin	400	„
„ „ „ Michigan	220	„
„ „ „ Nebraska	80	„
	1100	„
Stocks on hand	800	„
	1900	„

Against 3262 lbs.	in	1892
4700	„	1891
3245	„	1890

The sp. gr. of the oil is 0·925 to 0·950 at 15° C.

Besides the volatile oil, the plants of this genus possess an active bitter principle, *absinthine*.

The genus *Artemisia* is widely distributed over the temperate and warmer temperate regions of the globe and most of the species are remarkable for their strong odour and bitter taste. In this country three or four species grow wild. In certain of the Western States of North America, as Utah, Texas, New Mexico, are large tracts almost entirely destitute of other vegetation than that afforded by certain kinds of *Artemisia*, which cover vast plains, and give them an universal greyish-green hue. The plants are known under various names by the trappers, who find the gnarled and interlacing branches an almost insurmountable barrier to man and horse. The plants moreover are of no value as forage; the few wild animals that feed on them are said to have their flesh rendered of a bitter taste in consequence. The Artemisias also abound in the arid soil of the Tartarian Steppes, and in other similar situations.

The flower-stalks and heads of *several* species of *Artemisia* are sold by herbalists under the name of "Wormseed"; they are chiefly imported from the Levant and are the produce of plants growing in Syria, Persia, and Barbary. Others imported from India are employed as vermifuges.

Messrs. Schimmel & Co., have obtained a distillate from **Artemisia glacialis,** "Mountain Wormwood," known in commerce as "Genepi des Alpes." One hundred kilos of the herb yielded 250 grams of an essential oil of sp. gr. 0·964 at 20° C., which solidified to the consistence of butter at 0° C., in consequence of it containing a fat acid melting at 61° C. The boiling point of the oil was between 195° and 310° C. It had an unusually powerful aromatic odour, and it is thought it may be suitable for making "Benedictine" and "Chartreuse," for which purpose the herb is said to be used in France.

Artemisia Dracunculus, or "**Tarragon**" is a native of Siberia, and cultivated in Europe. It is raised from seeds and is of the easiest culture, but, like the rest of the species, it dislikes a wet soil. It differs from the majority of the species in that its leaves are undivided; they are narrow and lance-shaped, of a bright green colour and possess a peculiar aromatic taste without the characteristic bitterness of the genus. The leaves and points of the shoots are used as an ingredient in pickles, and in France under the name "Estragon" for many culinary purposes. The odour and taste of its essential oil is something like that of Anise bark, a fact which is ascribed to the presence of *Methyl-chavicol* in both oils, a body which yields anisic acid on oxidation.

The yield of volatile oil from Artemisia Dracunculus is estimated at 0·25 to 0·55 per cent., and its sp. gr. 0·92 to 0·96 at 15° C.

Messrs. Schimmel & Co., of Leipzig, are now for the first time in a position to supply Tarragon oil of their own distillation from their own plants, the cultivation of which is now established by that firm on a large scale. According to their Report of October, 1893, the product was distilled at three different periods during the summer and autumn of this year, the resulting oils being of exquisite quality. The oils obtained at these three different periods were examined as regards their physical qualities, with the following result:—

Sp. gr. at 15° C.	0·923;	Optical rotation	+ 5° 15′	in 100 m.m. tube
„	0·932;	„	+ 8° 10′	„
„	0·906;	„	+ 5° 45′	„

whereas two commercial samples from different sources gave the following results:—

Sp. gr. at 15° C.	0·944;	Optical rotation	+ 2° 50′	in 100 m.m. tube
„	0·935;	„	+ 2° 32′	„

Artemisia abrotanum, "Southern-wood" (*Garde-robe*, French) is a native of the south of Europe, and to some extent cultivated. It is a familiar garden plant in England and is known to country people as "Old Man." Its finely divided greyish-green leaves have a fragrant, refreshing odour and by distillation yield a small quantity of essential oil.

Eucalyptus.

The majority of the species of this genus of *Myrtaceæ*, numbering over 140, are natives of Australia and Tasmania, where they form characteristic features in the scenery of those countries. A few occur in New Zealand and in some of the islands of the Indian Archipelago. Most of them are large trees. They are distributed throughout all parts of the Australian continent, forming extensive forests, and are there generally known by the name of "Gum Trees" (by reason of the quantity of gum which exudes from their trunks), and are locally distinguished by characters observable in the bark, which, in some of the species is fibrous or stringy, in others hard and fissured, whilst sometimes it presents a smooth and polished surface, and occasionally it scales off in flakes. The botanical determination of the species is often difficult, owing to the close similarity of their floral structure, as well as to the various forms sometimes assumed by the foliage on different portions of the same tree, and the widely different appearances assumed by individual trees at different periods of growth. Maiden, in a valuable paper on "Medicinal plants indigenous to New South Wales,* says:—"It is very difficult to trace to individual species the properties ascribed to Eucalyptus and its products. Eucalyptus is a name very loosely used by many people, who forget that this large genus comprises (in Baron Mueller's "Census") no less than 134 species (while a fresh one is continually discovered), and some of these have varieties so well marked as to be classed as distinct species by some authors. It should not be lost sight of that in this vast genus the properties of different species are frequently very different, so that to describe a product as simply "Eucalyptus" is but a bald description, and one likely to lead to great confusion. There is some excuse for this, however, as Eucalyptus products

* Proc. of Linnean Soc. of New South Wales, 28th Mar., 1888.

have only been brought under notice during the past quarter of a century; and some allowance must be made to outsiders in respect to their references to a genus *so imperfectly known to Australians themselves.* The leaves and flowers are usually far removed from the ground (especially the flowers), and some apparatus not usually possessed by pedestrians, must be used to obtain the latter. They are therefore comparatively unfamiliar; this is doubtless partly the reason why they are not better known."*

As trees, the eucalypti are chiefly remarkable for their rapid growth, some attaining an immense height, and having proportionately thick trunks; one specimen in Victoria, a fallen one, was found to measure 480 feet in length, and specimens of *E. obliqua* (the "String-bark") have been felled in Tasmania, the trunks of which measured 300 feet in height, and 100 feet in circumference a yard from the ground. A plank of the "Swamp gum" tree forwarded to the International Exhibition of 1863, measured 230 feet in length.†

The leaves of many of the species are of a thick leathery texture, always quite entire, very variable in shape: in young plants they are always opposite, but they generally become alternate as the plant gets older, and their stalks then acquire a peculiar twist, so that the leaves present their edges to the branches. The flowers grow from the angles between the leaves and stem, and and are either solitary or in clusters. The calyx is hard and woody and separates into two pieces, the upper of which resembles a lid or cover, and falls away in a single piece when the flower opens, carrying along with it the corolla, which is intimately combined with it, while the lower piece is persistent, and bears the very numerous stamens which form a fringe round its summit. The fruit is closely enveloped in the woody calyx.

* The task of identification has, however, been greatly lessened by Von. Mueller's researches, published in his very valuable illustrated monograph, entitled "Eucalyptographia."

† For particulars as to the strength of the timber of these gum trees, see Gardeners' Chronicle, 1862, p. 571; the timber yielded by some of the species, notably that of *E. globulus*, *E. marginata* ("Jarrah" or Mahogany of South West Australia) and *E. robusta* ("Red-gum" of South Australia) is extremely valuable, not only on account of its strength, but by reason of its durability under water and its immunity from attacks by white ants.

Eucalyptus globulus was discovered in 1792 by Labillardière in Tasmania, and was introduced into Europe in 1856 by Ramel, who was the first observer of the beneficial effects produced by this tree when planted in malarious districts, also of its wonderful rapidity of growth, and it was due to his efforts that the tree soon acquired a great reputation. It requires about the same temperature as the orange. Its power of draining or drying marshy land, indicated by Ramel, has been abundantly proved, this eucalypt showing a predilection for soils of that nature. The wonderfully rapid growth of the tree, and the immense quantity of water it absorbes into its tissues, explains in some measure its power for land drainage, the salubrious effect of which is increased by the balsamic emanations from its leaves.

Its common name is " The Tasmanian or Victorian Blue Gum " and was originally confined by nature to these two Colonies. It likes a touch of frost, and hence when planted in the warmer parts of New South Wales (Sydney for example) it does not flourish, but forms a straggling, sickly, short-lived tree, a prey to insect life.

As regards the words " Blue Gum," the adjective " blue " refers to the bluish cast of the glaucous foliage, and occasionally bears reference to the tint of the smooth bark. Many species are known as Blue Gum in different localities.

Researches into the medicinal properties of this tree were first made, in Europe, by Tristani* and by Regulus Carlotti.† In 1870, Cloez discovered in the leaves of the eucalyptus (the only part of the tree used medicinally) a body which he named *Eucalyptol*,‡ afterwards examined, with somewhat different result, by Faust and Homeyer.§

Eucalyptol, $C_{10}H_{18}O$, is now known to be identical with *Cineol*. Maiden in his description of the different species of Eucalypts yielding oils,‖ says :—

* El. compilator medico, Janv., 1865.

† Mém. lue à la Soc. de Méd. d'Alger, published in Corsica, 1869.

‡ I. Campion, " L'Eucalyptus globulus et l'Eucalyptol," Paris, 1872 ; Comptes Rendus, 28 Mars, 1870 ; and Journ. de Pharm. et de Chim., 1870, xii., p. 201.

§ Ber. Deutsch. Chem. Ges., 1874, vii., p. 63 ; and Journ. de Pharm. et de Chim., 1874, xix., p. 495.

‖ Pharm. Journ. of Australasia, 15th March, 1892.

E. globulus and *E. amygdalina* are so frequently mentioned together, that it is convenient to describe their physical characteristics under one head, as follows:—It was for many years supposed that *E. globulus* oil contained eucalyptol, while *E. amygdalina* did not, but recent researches of Prof. Wallich have thrown a fresh light on the subject, *E. amygdalina* contains lævo-rotatory *phellandrene;* *E. globulus* on the other hand contains no phellandrene, but dextro-rotatory *pinene.* The common constituent of both these oils is *eucalyptol* or *eineol.* Wallich had at first some difficulty in isolating this substance from the oil of *E. amygdalina*, apparently owing to the disturbing presence of some impurity. This difficulty of separating eucalpytol from *E. amygdalina* naturally gave rise to the supposition that it did not occur in that species. The therapeutic effects of eucalyptus oil being considered to be largely dependent on the presence in it of eucalyptol, it is very satisfactory to learn that *E. amygdalina* (one of the most abundant yielders of eucalyptus oil) contains that body. If for no other reason than an endeavour to secure uniformity of oils, it is desirable that as far as possible, they be given their own species name. To use the words of a large user of eucalyptus oil, "the oil they always obtaind was labelled *E. globulus*, and sometimes by way of a change, *E. amygdalina*, for the two things seemed exactly the same." In a word *E. globulus* in very many instances, should be read "*Eucalyptus*." Oil labelled *E. globulus* should in fact be looked upon as only provisionally labelled, unless the accuracy of the labelling be guaranteed by a firm of repute and experience in this matter. No species of eucalyptus has been more persistently advertised (for planting, etc.) than *E. globulus*, and a number of people have at length got to imagine that there are no other species—at all events of any importance.

Comparatively little *E. globulus* oil is distilled in Australia, but as this species has been largely selected for planting in Algeria and California, a good deal of veritable *E. globulus* is produced by these two countries.

As regards the popular opinion that oil of *E. globulus* is of greater therapeutic value than that of *E. amygdalina*, *E. eneorifolia* and other eucalypts, attention has recently been directed,* by the Curator of the Museum of the Pharmaceutical Society, to the

* Pharm. Journ. [3], xxii., p. 877, 23rd April, 1892.

somewhat unsatisfactory state of our knowledge of the eucalyptus oils of commerce:—"As long ago as 1885, when the oil of Eucalyptus was first made official in the British Pharmacopœia, Mr. C. B. Allen pointed out in the pages of the Pharmaceutical Journal* the difficulties that arise when the oil of one species of eucalyptus is dispensed at one house of business and that of a different kind at another. The fact that the Pharmacopœia allows the use of the oil of *E. globulus, E. amygdalina* and other species (which may have different odours), places the pharmacist in a very awkward position whenever a new oil of eucalyptus appears in commerce. During the last two years a new variety of eucalyptus oil has been introduced into this country under the name of oil of *E. oleosa.* This oil has a decided odour of cummin and in that respect is quite different from an oil which formerly bore the name of "oleosa." The oil with the cummin odour is obtained from *E. cneorifolia,* which was formerly considered by Sir F. von Mueller to be a variety of *E. oleosa.* When *E. globulus* was first brought into notice as an anti-malarial agent, its properties were considered to be due in a large measure to the volatile oil of its leaves. Eucalyptus oil, therefore, soon came into use in medicine, but the oil which entered commerce in this country was not that of *E. globulus,* but *E. amygdalina,* an oil which had for some time previously been in use in Australia. The reason for this is obvious, when it is understood that *E. amygdalina* yields nearly four times as much oil as *E. globulus,* and that the oil also possesses a much more agreeable odour. After a few years the *E. amygdalina* tree appears to have become scarce in the neighbourhood of the distilleries, and recourse was had to the "mallee scrub," a copse-like growth of small trees, about 25 feet in height and extending over large districts. The eucalypts of which it is composed are chiefly of four species, viz.:—*E. oleosa, E. dumosa, E. gracilis* and *E. uncinata.* The oil thus obtained entered commerce under the names of *E. oleosa* and *E. dumosa.* At the time (1885) that the Pharmacopœia authorized the use of *E. globulus,* the cultivation of this species had spread to a large extent in Algeria, Spain and the South of France. Oil of *Eucalyptus globulus* therefore soon appeared in commerce from these sources, as well as from Tasmania, and also from California, where it is obtained as a by-product in the preparation of a preventive of steam-boiler

* Pharm. Journ., [3], xvi., p. 537, 23rd April, 1892.

incrustation. The oil of *E. globulus* from all these sources is by no means uniform in character, some samples having a rank odour like that of the leaves, others a camphoraceous but not unpleasant odour, as if they had been rectified by re-distillation. Some samples from the South of France possessed an odour of turpentine. In those from Algeria and Malaga there is often a savin-like odour, due perhaps to a still having been used for eucalyptus after the distillation of savin. Eucalyptus oil is largely used, as an inhalation, in diseases of the lungs. For this purpose, oils of *E. amygdalina* and *E. dumosa* are preferred in Edinburgh and elsewhere" (a remarkable fact, as the former oil consists principally of phellandrene). "It is also remarkable that much of the eucalyptol, that was first used in medicine, consisted of the first portion passing over in the distillation of the oil and contained a quantity of phellandrene. The evidence therefore seems to point to the fact that oils containing phellandrene are preferred for the treatment of lung disease, and it is desirable that experiments should be made with this body, by physiologists, in order to determine whether the properties of eucalyptus are due to eucalyptol, phellandrene, or some other ingredient of the oil, and it may be hoped that in the next Pharmacopœia, a product of definite composition, extracted from eucalyptus oil, may take the place of an oil of unknown and indefinite composition."*

There is no difficulty in procuring phellandrene in a fair degree of purity from *E. amygdalina*, and the oil is still sufficiently plentiful. Also eucalyptol can easily be prepared in considerable quantity from *E. cneorifolia*; therefore the medicinal value of the constituents of eucalyptus oil is a point which might easily be settled by medical men. In any case, **eucalyptol** has a less agreeable aroma and flavour than eucalyptus oil itself, and a manufacturer of perfumes might fairly estimate the value of an oil by its fineness of odour, and not by its per centage content of eucalyptol or any ingredient of inferior odour on the simple ground of its therapeutic merit. Eucalyptol (or cineol) is obtainable from the essential oils of various plants, and the more it is purified the more it loses the characteristic odour of the source from whence

* Opinion confirmed by Dott at Meeting of Pharm. Soc., Edinburgh, 13th Dec., 1893. Reported in Pharm. Journ., xxiv., p. 511.

derived, also the more these eucalyptols from various sources become identical, and lose traces of odour by which they were distinguished.*

Besides being found in many eucalyptus oils, such as *E. globulus*, *D. dumosa*, *E. encorifolia* D.C., *E. oleosa*, *E. amygdalina*, *E. Baileyana* and *E. microcorys*, &c., eucalyptol has been detected in the following essential oils :—

Oil of Wormseed ...	*Artemisia Cina...* ...	by Wallich & Brass.
„ Cajuput ...	*Melaleuca Leucodendron..*	„ Wallich.
„ Rosemary ...	*Rosmarinus officinalis...*	„ Weber.
„ Spike	*Lavandula spica* ...	„ Voiry.
„ Cheken-leaf ...	*Myrtus Cheken ...* ...	„ Weiss.
„ Myrtle ...	*Myrtus communis* ...	„ Jahns.
„ Camphor ...	*Laurus camphora* ...	„ Schimmel & Co.
„ Sage	*Salvia officinalis* ...	„ Wallich.
„ Lavender ...	*Lavandula Stœchas* ...	„ Schimmel & Co.
„ „ ...	„ *dentata* ...	„ „
„ Galanga ...	*Alpinia Galanga* ...	„ „
„ Zedoary ...	*Curcuma zedoaria* ...	„ „
„ California laurel	*Oreodaphne Californica*	„ „
„ White cinnamon	*Canella alba*	„ „
„ Laurel berry ...	*Laurus communis* ...	„ Wallich.
„ „ leaf ...	„ „ ...	„ „

As cineol has been isolated from such a number of oils of different odours, and as its physical characters are so altered by the presence of small quantities of other bodies, it has in many cases been considered a distinct substance and received a different name, as the eucalyptol of eucalyptus oils, and *cajuputol* of cajuput oil.

Cineol (or eucalyptol) is readily converted into dipentene derivatives by the action of halogen acids, but when dry hydrobromic acid is passed into a dry ethereal solution of cineol, a white crystalline hydrobromide $C_{10}H_{18}O\,H\,Br.$ melting at 56°-57°C., and decomposing immediately with water, is deposited. The formation of this hydrobromide and of cineolic acid when the

* For description of phellandrene and names of oils containing it, see "Elemi."

alcoholic solution is cautiously oxidised with permanganate of potash, furnish the most reliable chemical tests for cineol.*

An elaborate investigation of the physical properties of eucalyptol was made in 1892 by Davies and Pearmain, and read at a meeting of the British Pharmaceutical Conference at Edinburgh, 23rd Aug., 1892. The eucalyptol examined was prepared in a state of great purity by "the freezing-out process": The temperature produced by a mixture of two parts of snow with one of salt was—20·5° C. (= —5° F.), and working in the open air (February), the atmospheric temperature being at the freezing point or a few degrees below, "it was easy to keep quantities of between one and two lbs. at or just below —18° C. (zero F.) for an hour or more." (A lower temperature is obtainable by using snow than crushed ice, owing to its finer state of division.)

At this low temperature it was found that without any previous fractionation, three samples of oil gave abundance of crystals. These samples were the oils of "*Eucalyptus oleosa*" so-called, (now known as the product of *E. cneorifolia*, D.C.), *E. dumosa*, and one stated by the importers as from *E. globulus*. After allowing time for crystallisation, the whole was transferred to a small hand-press capable of holding a quart, which was previously cooled, and after the oil had drained off, the crystals were submitted to strong pressure, a firm white cake of eucalyptol being obtained. This was subsequently mixed with a similar product from two further supplies of oil, and the whole re-frozen and pressed twice. This constituted the bulk of the eucalyptol obtained. Some of it was very carefully distilled, using a "Bell Henninger's" fractionating tube, and it was found that on this distillation, out of 75 c. c. taken, 69 c. c. distilled at 174°·5 C. Of this 69 c. c., on redistillation, 67 c. c. distilled at 175°C by another thermometer; and on this 67 c. c. being again distilled, it entirely came over between 174° and 175°, using a third thermometer. The boiling point of eucalyptol may therefore be assumed to be 174°·5 (uncorrected).

The thrice distilled product was examined as to action on polarised light, using a column of 220 m. m. The rotation, judging from three closely concordant observations, was —10′·7 from which the rotation of 100 m. m., would be —4′·8. The

* British and Colonial Druggist, xxii., p. 534.

observers remark :—" In our previous paper we have alluded to a sample of 'pure eucalyptol' which we stated to have no rotation. This observation we find to be not strictly accurate. A column of 100 m. m. only was examined, and the deviation, when compared with those of other samples of eucalyptol, seemed to justify this opinion. On examination some months later, using a 220 m. m. tube, it was found to deviate the ray + 16′, equal to + 7′ for the 100 m. m. tube. Our eucalyptol has therefore a smaller rotation, and in an opposite direction to the sample we had regarded as pure.

" The melting point of the crystals was 0° to 0°·5 C., and the solidifying point of the liquid —1° to 0°C. The sp. gr. was taken at the temperature of 4°C., 10°·5 C., 25°C. and 100°C., the comparison being made in each case with water at the same temperature. At 4°C., the gravity was ·9342 ; at 10°C., ·9139 ; at 15°·5, ·9275 ; at 25°, ·9216 ; at 100°, ·8910.

" In the mention of this substance in Watt's Dictionary, 2 ed., ii., p. 536, it is indicated that eucalyptol is probably identical with cineol, a remark that most recent workers endorse, but the sp. gr. of cineol is stated to be ·927 at 16°C., as against ·923 for eucalyptol. Our eucalyptol ·9275 thus confirms the statement that eucalyptol is identical with cineol."*

(Various figures have been assigned as to the sp. gr. of eucalyptol. Jahn gives 0·923 at 16° C., and 0·940 at 0° C.†; Merck gives as properties of " Eucalyptol puriss," boiling point 170°-173° C. ; sp. gr. 910-920 at 15° C.‡ ; Schimmel§ says : 0·930 at 15° C. Constant boiling point 176°-177° C).

" Some experiments were made to ascertain how far the amount of eucalyptol that crystallised out could be taken as a measure of that contained in the oil submitted to cooling. For this purpose the eucalyptol was mixed in various proportions with substances regarded as containing no eucalyptol, and the mixture submitted to freezing. The diluents chosen were (*a*) the fraction of *E. amygdalina* coming over above 177° C., and (*b*) absolute alcohol.

* Pharm. Journ. [3], xxiii., p. 205.

† Ibid., xv., p. 615.

‡ Ibid, xiv., p. 778.

§ Bericht., April, 1890.

(*a*) Diluting with the fraction of amygdalina oil :—

PARTS.		PARTS.			
75	eucalyptol,	25	diluent,	froze hard ...	...—20°·5 C (—5° F)
70	,,	30	,,	froze	...—20°·0 C (—4° F)
66·25	,,	32·75	,,	,, ...	...—20°·5 C (—5° F)
62·5	,,	37·5	,,	doubtful ...	...—21°·0 C (—6° F)
50	,,	50	,,	would not freeze	...—21°·0 C (—6° F)

(*b*) The results with alcohol were of a very similar character :—

PARTS.		PARTS.			
75	eucalyptol,	25	alcohol,	crystallised readily	...—16°·5 C (+2° F)
70	,,	30	,,	froze	...—18°·3 C (+1° F)
65	,,	35	,,	froze with difficulty	...—19°·5 C (—3° F)
60	,,	40	,,	would not crystallise.	

The deductions from these experiments would seem to be that the process of freezing permits of a very large proportion of the eucalyptol remaining in the oil, the mother liquor of the crystals containing still somewhat more than 60 per cent. of its weight of true eucalyptol. So that though when combined with fractionation this process is extremely useful for distinguishing between oils rich and poor in this constituent, it will not serve as an accurate process for estimating the amount of eucalyptol the oil contains, though by making a correction for this eucalyptol in solution in accordance with the above results, a better approach to accuracy will be obtained."

The essential oils of Eucalyptus were first brought into prominent notice by Mr. J. Bosisto, of Melbourne, and are now employed for a great variety of purposes. An essential oil is produced in greater or less quantity by different species of Eucalyptus, the properties of the oil varying with each, but data determined from Australian distilled oils cannot be relied on, leaves of different species being mixed in the still.

A useful contribution to the natural history of the *Eucalpti* is given by A. W. Howitt,* who enumerates nearly fifty species, natives of Gippsland. He classifies them under a number of types, giving the botanical characters of the various groups and of the more important species. Howitt states that the eucalypt forests have greatly increased in extent since the first settlement in

* Trans. Royal Soc. Victoria, ii., pt. 1.

Gippsland, a fact which he attributes to the checking of bush-fires by the colonists. A table is appended showing the range in altitude of the various species, and nine plates chiefly illustrating the characters derived from the older and younger leaves, anthers, flower-buds, fruit, &c. In the same volume McAlpine and Remfrey have a paper on "The Transverse Sections of Petioles of Eucalypts as Aids to the Determination of Species." Sections of thirty different kinds are described and *photographed*, showing unmistakably, along with a general resemblance, differences which are more or less constant and readily recognisable for each species. The organs and parts chiefly relied on as furnishing specific characters are the epiderm, the hard bast, the xylem with its vessels, the cortical cavities, and the central canals. The size and shape of the transverse section of the petiole is also often characteristic.

Sig. G. Briosi has recently undertaken an exhaustive investigation of the anatomical structure of the leaves of *E. globulus*.* The leaves are of three kinds, the cotyledons, the earlier horizontal, and the later vertical leaves, the last two passing into one another by insensible gradations. The vertical form is regarded as an adaptation to the intensity of the light, in order to prevent too great transpiration. The glands in the leaves are apparently also a protection against the action of heat. The glands are distributed abundantly, but irregularly, through the tissues of the leaf, and occur even in organs which are destitute of stomates, as the petiole, receptacle, ovary, &c., and occasionally, though rarely, in the pith. They are of lysigenous origin, the neighbouring cells are modified in structure, the wall adjoining the gland no longer yielding the cellulose reaction; and these walls combine so completely that the gland has the appearance of a closed sac.

When Eucalpytus leaves are carefully dried in the shade they are found to lose moisture as follows :—

E. amygdalina	...	...	loses in weight	50	per cent.
E. globulus	...	...	„	50	„
E. viminalis	...	...	„	41	„
E. rostata...	...	...	„	58	„

(Raveret-Wattel).

* Ricerche intorno all' anatomio delle foglie dell' *Eucalyptus Globulus*, 23 pl., Milano.

Messrs. Schimmel have found the yield from dried leaves of E. globulus to be 3 per cent., the sp. gr. of same being 0·925 at 10° C., 0·922 at 15° C., and 0·918 at 20° C. Rotation always dextrogyre, varying in commercial oils from + 1° to + 20° (according to purity).

Six commercial samples examined varied from 50 to 70 per cent. in the amount of eucalyptol they contained. "In distilling the leaves of *E. globulus,* aldehydes of the fatty acids were observed; the presence of valeric-aldehyde was determined with certainty, and apparently butyric-aldehyde and caproic-aldehyde were also present. The greater part of these bodies was dissolved in the aqueous distillate, but the valeric-aldehyde could also be detected in the oil. It was also present in two commercial samples of the oil."*

The odour of oil of *E. globulus* is difficult to describe; it pertains of camphor, cajuput, laurel, lavender and turpentine. In bulk it is overpowering, but diluted, it is a useful ingredient in several acetic ahd ammoniacal perfumes.

Maiden† distinguishes as "Mallee oils" those produced by dwarf eucalypts common in arid regions (such as the great Murray Desert). The word "Mallee" is of aboriginal origin. There is more or less of this "Mallee scrub" or Mallee country in the interior of all parts of the Colony. The bush grows to no great height, but as it sends out branches from the base it frequently forms impenetrable belts. The principal eucalypts forming this scrub are:—*E. dumosa, E. gracilis, E. oleosa, E. incrassata, E. pyriformis, E. eneorifolia, E. societis* and *E. uncinata.* Many of these Mallee eucalypts yield abundance of very good oil, which has the advantage of approximately constant composition, the members of each species being very gregarious (in fact, the Mallee scrub is too abundant and gregarious to suit most squatters). The meaning of "approximate constant constitution" is—although the distillers are not over particular in sorting the leaves according to species, they have not the opportunity of bundling into the still the leaves of such a variety of eucalypts as are found in other localities. It is impossible to draw too much

* Bericht., April, 1888, and confirmed by Oliviero in 1893, Bulletin de la Soc. Chim. de Paris, ix., p. 429.

† Pharm. Journ. of Australasia, 13th Mar., 1892.

attention to this point. The study of the eucalypts may be difficult, by reason of the great number of species, but commercially it is of importance; the value of the oil yielded by each species being different.

E. cneorifolia, D.C. This species is not of frequent occurrence in Australia, and is not as yet propagated to any extent there. It is found almost exclusively on Kangaroo Island, along the banks of the Cygnet River. It is a small scrub of about twelve feet in height and much branched at the base. It is locally known by the name of "narrow-leaved eucalyptus." This tree is very nearly allied to *E. oleosa*, of which it was originally regarded as a sub-species. Owing to the increased demand for this oil, which is of excellent quality and wonderfully rich in eucalyptol, works have been established on the island for its extraction. The sp. gr. of the oil is 0·923 at 15·5 C., 72 per cent. of it boiling between 170° and 180° C.* In its higher boiling fraction, viz., from about 200° to 220°, there is a product having an odour reminding of dill and caraway and somewhat of lemon; this probably contains *cumin aldehyde* and *citral.*

E. dumosa forms, with *E. gracilis* and other species, the "Mallee country" of North Western Victoria, Southern New South Wales, and South Australia. Its oil has a strong camphoraceous odour. Sp. gr. 0·912.

E. gracilis, Mueller, inhabits the same districts as *E. dumosa*, also Queensland. It yields rather a lower percentage of oil than any of the other mallees. Maiden says (Useful Native Plants of Australia), that 1000 lbs. of fresh twigs yielded 54½ ozs. of oil, but he does not mention the odour of this oil.

E. incrassata, Labil. 1000 lbs. of fresh branches, about half of which weight consisted of leaves, yielded 140 ozs. of oil. No remark is made by Maiden as to the odour and other properties.

E. uncinata Turcz. According to Baron Mueller 1000 lbs. of branches with about 500 lbs. of leaves, yielded 69 ozs. of oil, but no remark is made as to odour and other properties. The tree inhabits West and South Australia, Victoria and New South Wales.

* Schimmel, Bericht., April, 1891.

It is reported that the firm James Robertson & Co., of Melbourne, has devoted itself with great energy to the preparation of Eucalyptus oil, and has erected a factory on Lake Hindmarck (Victoria), not far from the railway that passes from Melbourne to Adelaide, and will principally confine itself to the preparation of oils with a high percentage of Cineol. The firm believes that the conditions on the banks of the above-named lake are more favourable than anywhere else, and will especially attend to the distillation of *E. cneorifolia*, *E. gracilis*, *E. uncinata* and *E. incrassata*.

The manner of estimating such oils as the above (and many others), by the percentage of Cineol (eucalyptol) is absolutely necessary, because it is impracticable (as is admitted at the sources of production) to successfully maintain a distinction between the differents sorts of material.

E. amygdalina, the "Narrow-leaved peppermint tree," also called the "Brown or White Peppermint tree of Victoria." It is found in south-eastern South Australia, throughout Tasmania and Victoria, and in the extreme south of New South Wales. This is another tree of colossal dimensions, generally attaining a height of 150 feet, with a trunk sometimes 8 feet in diameter at the surface of the earth; some old trees have been found of 480 in height with a trunk 81 feet in circumference at 4 feet from the earth. Such trees only commence to branch out at a height of 295 feet. (The *Wellingtonia gigantea*, of California, is the only tree rivalling it in size).

The yield of essential oil from fresh leaves of *E. amygdalina* has been estimated at from 2 to 4 per cent.* Mueller † states the yield to be 3·13 per cent. Staiger says the leaves yield 1,250 ounces per ton.

Its sp. gr. is 0·86 to 0·89 at 15° C. It boils practically between 170° and 180° C., and is lævogyre. Observations on three different samples gave, in a hundred m.m. column, a rotatory power of —27°, —28° and —28°6′; consequently this property allows of it being easily distinguished from the dextrogyre oil of *E. globulus*.

* Raveret-Wattel, L'Eucalyptus, sa culture, proprietés, etc., Paris, chez la Librairie centrale d' Agriculture, p. 26.

† Select extra tropical plants, p. 146.

Squire* remarks that an oil frequently comes on the market as that of *E. amygdalina*, which contains no phellandrene and which twists a ray of polarised light to the right instead of to the left. Other observers, on examining samples of oil of *E. amygdalina* received direct from Australia have found the content of phellandrene to be very small and the optical power feebly dextro-rotatory.

Respecting the samples of Australian distilled oils arriving in Europe, Messrs. Schimmel express the opinion† that "the various kinds of eucalyptus leaves are no longer carefully kept separate during distillation, and that, therefore, the designation of the oil does not always entirely correspond with its origin." On such a supposition, it is not surprising that the physical properties of different parcels of oil labelled with the same name, should, on examination, give very different results, the recorded data of such being very misleading.

E. rostrata, Schlechtendal, or "Red gum," possesses very similar qualities to *E. globulus*, and in some respects superior ones. It is a tall, handsome tree found on the banks of rivers and in very moist localities, where it sometimes attains gigantic proportions. It is found in nearly all parts of Australia, but does not occur in Tasmania. In mountainous districts it is rare, and its presence on arid plains is a certain indication of small water-courses having at some previous period existed there. It furnishes a very hard wood of a beautiful red colour, much esteemed by cabinet makers, who especially make use of the excrescences of the trunk and roots, the wood of which is very elegantly veined.

As a wood capable of resisting the action of water or of a damp atmosphere, it is unrivalled. It possesses the same anti-malarial properties as a "land drainer" as the *E. globulus*, possibly to even a greater degree, and will thrive in many localities where *E. globulus* will not, as has been proved in Cochin-China. This tree has been introduced into Algeria (where it resists the heat better than *E. globulus*),‡ and the essential oil of its leaves

* Chemist and Druggist, Sept., 1890.

† Bericht, Oct., 1890.

‡ It is estimated that at the end of 1888 there were 3,000,000 eucalypts of various species planted in Algeria, and sufficiently grown to be in bearing condition.

distilled by E. Mojon, of Algiers. It has also been introduced into the South of France. The odour of the oil reminds of that of *E. odorata.* Messrs. Schimmel say it has a powerful odour of *Valerianic aldehyde*, and that it is rich in cineol; they determined its sp. gr. to be 0·924 at 15° C, and the optical activity + 12° 58′ in a 100 m. m. tube.*

E. Baileyana, Mueller, is a "stringy bark" eucalypt of local distribution, being confined to Northern New South Wales and Southern Queensland (Brisbane). The fresh leaves yield 0·9 per cent., which, according to Maiden, has a melissa-like perfume, and sp. gr. 0·980, which may be a mistake, as Staiger (the Government chemist) states it at 0·890.

E. dealbata is confined to the drier portion of Queensland and New South Wales. Its oil is considered by some persons to possess the finest odour of all the eucalypts. It is something between lemon and melissa, sp. gr. 0·885; boiling from 206°-216°.

E. maculata, var. citriodora, Hook, sometimes called "The citron-scented eucalypt." It is found along the Queensland coast districts and southwards to Port Jackson. It is a variety of the well-known "spotted gum" of New South Wales, whose leaves possess no marked perfume. The *citriodora* variety is especially abundant in Port Curtis district, and near the town of Gladstone (Queensland), and an enterprising pharmacist there has entered into the distillation of the oil largely, working off half-a-ton of leaves daily.

The yield from the fresh leaves is said to be 1½ per cent. From the dried leaves as much as 3·7 has been obtained. Its sp. gr. has been determined by Messrs. Schimmel at 0·873 at 15° C., who give the following information† concerning it:—"When distilled, about ¾ of it goes over between 205° and 210°, while smaller fractions boil under and over those temperatures. The fraction 205°-210°, amounting to about 75 per cent. of the crude oil, consists almost entirely of pure *Citronellon*." Some samples more recently examined (received from the Queensland Eucalyptus Company have been found to contain as much as 95 per cent. of citronellon; the

* Wittstein and Mueller state the sp. gr. as 0·918, and the boiling point as 137°-181° C.

† Bericht, Oct., 1890.

remaining 5 per cent. being geraniol.* Oil of *E. maculata, var. citriodora* possesses the characteristic property of being soluble in 4 to 5 parts of 70 per cent. alcohol.†

Citronellon is an aldehyde possessing some analogy to *Citral* (which see) but distilling at a lower temperature. It is the chief constituent of oil of *Andropogon Nardus* (citronella) (see 1st series), and was isolated from that oil by Dodge,‡ who ascribed to it the formula $C_{10}H_{18}O$. By treatment with sodium amalgam, it can be converted into *Citronellyl alcohol,* $C_{10}H_{20}O$. By oxidation it yields *citronellic acid* $C_{10}H_{18}O_2$.

In the above-mentioned paper by Dodge, he says, in reference to the separation of this aldehyde from oil of citronella:—"When the oil is shaken with a saturated solution of sodium bisulphite, after ten minutes the liquid solidifies with considerable evolution of heat. On standing, the mass becomes yellow on the surface, owing to oxidation of other constituents of the oil. The bisulphite compound is readily obtained pure by thinning with ether or chloroform, filtering and washing with the same solvents, in which the precipitate is practically insoluble. Alcohol does not work so well. The bisulphite precipitate is readily decomposed by acids, alkalies, sodium carbonate, or hot water, which regenerate the aldehyde." As regards the isolation of the aldehyde, he says:—"The washed bisulphite compound, freed from ether by short exposure to the air, was gradually added to a warm solution of sodic carbonate and kept warm until the white precipitate had disappeared. The supernatant oil was then separated and dried. On distillation, the greater part boiled from 200°-210° C., leaving a thick residue which did not react very readily with phenyl-hydrazine. This indicated an alteration of the aldehyde due to the heat of distillation. To avoid this difficulty, the oil liberated from the bisulphite compound was immediately distilled in a current of steam; a plan which succeeded admirably, a pure white oil passing over, and a small quantity of dark-coloured oil remaining in the flask." Operating upon a larger quantity he details the process as follows:—Two litres of citronella were distilled; the first portion of the distillate, 1100 c. c., was divided into four parts of about

* Bericht, Oct., 1893.

† Ibid.

‡ Am. Chem. Journ., xi., pp. 456 and 469.

280 c. c. each. The bisulphite solution contained 1000 grams dry sodium bisulphite in two litres of water. 250 c. c. of this was added to each portion of oil and the mixture well stirred. During the stirring the vessels were kept cool with ice water. After about ten minutes the mixture "set," forming a snow-white magma. The remainder of the bisulphite was now gradually added, stirring all the time. A further evolution of heat took place until all the oil had been precipitated. After standing about an hour the mass was wrapped in flannel and after draining on a large funnel, was carefully pressed in a filter-press. When the mass was pretty dry it was removed from the press, thinned out thoroughly with ether, and again drained and pressed. The bisulphite compound was now tolerably free from residual oil. To remove the ether it was exposed to the air for several hours. At this stage it has the appearance of wax. On long exposure it decomposes, turning yellow on the surface. To liberate the aldehyde the dry mass was mixed with crystallised sodic carbonate, 450 grams of the former to 350 grams of the latter, in a large flask. Steam was then passed into the mixture, which soon liquefied and yielded the aldehyde as a distillate.

The steam-distilled aldehyde, after drying several days over calcic chloride, is a colourless oil having a sp. gr. at 25° C. of 0·8509. It commences to boil at 202° C. and the temperature slowly rises to 207° C., after which, it rises more rapidly (being decomposed by the heat) and a resinous mass remains in the flask. The vapour density determination by the method of Victor Meyer gave D = 5·405 : calc. = 5·34. This aldehyde appears to be dextrogyre; a column 2 decimetres long produces a deviation of about 7° for sodium light.

The aldehyde readily absorbs bromine, the solution becoming warm. If the temperature rises too much, hydrobromic acid is given off and decomposition takes place. To determine the amount of bromine absorbed, it was found convenient to weigh quickly about one gram. of aldehyde, dissolve it in 20 c. c. of chloroform or carbon disulphide, and run in, from a burette, a standardised solution of bromine in carbon disulphide, until a slight permanent red coloration was obtained. The bromine solution used contained 0·1163 gram. bromine per c. c. The following results were obtained:—

I.—1·084 gram. aldehyde required 9 c. c. Br. solution.
II.—1·885 „ „ „ 16·2 „ „
III.—2·0149 „ „ „ 17·5 „ „

I.		II.		III.		Calculated $Br._2$		$Br._4$
49·1	...	49·9	...	50·3	...	50·9	...	67·5

These results, though only approximate, are yet sufficient to show that the unsaturation of the aldehyde is equivalent to two atoms of bromine.

The aldehyde was reduced in the following way: 25 grams. of aldehyde were mixed with 15 grams. glacial acetic acid, 400 grams. of 5 per cent. sodium amalgam were gradually added, with occasional washing to remove the acetate formed. The resulting liquid was dissolved in ether, shaken up with bisulphite solution to remove any unchanged aldehyde, boiled with a little alkali to saponify any acetic ester possibly formed, washed, dried and distilled. The greater part boiled at 225° to 230° C. It decolorised bromine solution, and possessed a pleasant *odour of roses.*

The odour of rose was also noticed by Dodge in the filtrate from the bisulphite precipitate above described. The oil yielded by the first pressing was collected apart. The ethereal washings were dried, and, after removal of the ether, combined with the first. The product, a light yellow oil of peculiar odour, was now carefully fractionated. It commenced to boil at 185° C., and the temperature rose steadily to 240° C., above which it was considered unnecessary to fraction. At the tenth distillation the oil was almost completely separated into three portions. The first, a limpid colourless oil having a lemon-like odour, boiled at 177° to 180° C., and out of the original quantity of 350 c. c. amounted to 75 c. c. The second, a somewhat thicker oil, of slightly greenish colour, and having a pleasant *rose-like* odour, boiled at 222° to 224°, and amounted to 120 c. c. The third portion consisted of products boiling above 240°.

When oil of *E. maculata var. citriodora* is shaken with a solution of sodium bisulphite, or treated in the same way as described for oil of critronella, the mixture becomes hot and changes to a solid mass, from which, after washing with ether, pure Citronellon separates on decomposition with soda solution. The fraction

boiling under 200° C., which amounted to about 4 per cent., showed none of the characteristic reactions of Cineol (Eucalyptol), and it must therefore be assumed that this body is not present in the oil of *Eucalyptus maculata var. citriodora.* The well rectified oil is colourless, and has a pleasant melissa-like odour.

It is considered that the oils of *E. Baileyana, E. microcorys* and *E. maculata var. citriodora* are very similar in composition. Citronellon has been found in *E. dealbata.*

E. microcorys, Mueller, called the "Sallow wood" of Northern New South Wales, is found in the Coast districts to Cleveland Bay. The yield from the fresh leaves is nearly 2 per cent., sp. gr. 0·896, boils at 160° to 200° (Staiger).

E. Staigeriana. The "Lemon-scented Iron Bark" of the Palmer River, Queensland. The leaves are obtainable from Maytown ; they possess an odour very like that of scented verbena. Staiger says the odour of the oil is so exactly like that of oil of verbena that it would be difficult to distinguish it by its odour alone, although it differs in its lower specific gravity, which is 0·871 or when freed from moisture 0·880*, that of verbena being 0·890.† The oil, when fresh, contains from 0·1 per cent. to 0·3 per cent. of water, which can easily be removed by calcic chloride. An important constituent of oil of *E. Staigeriana* is *Citral* $C_{10}H_{16}O$, an aldehyde that is of very frequent and extensive occurrence in essential oils, and especially occasions the characteristic aroma of lemon oils and oils having a lemon-like and verbena odour, such as those of *Andropogon Citratus* (Lemon-grass), *Backhausia Citriodora,* and the fruit of *Tetranthera citrata.* The elementary arrangement of Citral is doubtful, but the fact that *geraniol* is converted into *citral* by oxidation, and citral itself into *geranic acid,* suggests that it is also a chain compound with the corresponding formula :—

$$\begin{array}{l} CH_3 \\ \qquad\diagdown \\ \qquad\quad CH-CH_2-CH=CH-C(CH_3)=CH-CHO \\ \qquad\diagup \\ CH_3 \end{array}$$

* Pharm. Journ. [3], xvii., p. 142.

† Ibid [3], x., p. 212

E. haemostoma, Smith. A "white gum." Illawarra, New South Wales to Wide Bay, Queensland. The tree is said by Dr. Bancroft to be plentiful and yield a colourless oil of odour intermediate between that of geranium and peppermint. The yield from fresh leaves being 672 ounces per ton, sp. gr. 0·880 (Maiden). Schimmel says 0·890, and boils from 170° to 250°.* This oil differs from all other described eucalyptus oils, and has an odour resembling that of cumin oil. It contains cumin-aldehyde, cymol, and among the oxygenated constituents one having a peppermint odour, probably *menthon*.

E. capitellata, Smith, found in Victoria and Queensland. This oil has not been examined, but its odour is said to be scarcely distinguishable from that of peppermint.

E. populifolia, Hook. "Bimbil Box" of New South Wales, Queensland and North Australia. The oil from this tree is interesting from the fact that it resembles cajuput more than any other eucalyptus oil. In colour it is bright red. It contains cymin-aldehyde and a fair proportion of cineol.

E. corymbosa, Smith. The "Bloodwood tree." It is found on the coast of New South Wales and South Queensland. This is one of the most suitable of eucalypts for a dry soil. Maiden states the odour of its essential oil to resemble a mixture of lemon and rose, and its taste to be bitter and somewhat camphoraceous. It is colourless, of sp. gr. 0·881 at 15° C. According to Bosisto, 100 lbs of leaves yielded 90 ozs. 3 drs. of oil. It is rich in cineol.

E. goniocalyx Mueller, one of the trees known as "White Gum." This species forms a very tall tree, and is especially found in humid forests on the mountains. It is unknown in Tasmania, and seems limited to the most fertile districts of Victoria and New South Wales. In southern New South Wales it is known as "Blue Gum," being sometimes known in Victoria as the "Spotted Gum tree." From the barks of both this and *E. corymbosa* an excellent paper is manufactured; its wood being very hard and close grained, is much used for building purposes, but its essential is valueless, except perhaps as a curiosity or for investigation, as it possesses a suffocating, penetrating, unpleasant odour and repulsive taste. In

* Schimmel and C. Bericht, April, 1888.

colour it is bright yellow, sp. gr. 0·918, boiling point 0.152°-175° C. 100 lbs. of fresh leaves yielded 90 ozs. of oil.

E. piperita is mentioned by Maiden amongst other species referred to in his paper already quoted* as the New South Wales "Peppermint tree," "well known for the abundance of oil its leaves contain, and which attracts attention during the very first year of settlement in Australia. Oil is made from it on a commercial scale in at least one district." This oil does not seem to be known commercially in Europe. Other trees of similar properties are mentioned by Raveret Wattel; these are:—

E. melliodora, Cunningham, commonly known as "Box tree," "Yellow Box tree" and "Peppermint tree." This tree seems to prefer rather open and high-lying localities. Cordier says humidity does not suit it.

E. odorata, Schl., is also known as a "Peppermint tree." It succeeds best on calcareous soil in elevated situations which are not overshadowed. As it does not suffer by drought, it is one of the species intended for trial in the Algerian Sahara, having already been grown with success in light dry soil in Algeria. It is unknown in Tasmania, and is only known on the Australian continent.

Some time ago, samples of oil labelled *E. odorata*, were reported† as having been received from Adelaide, which, on examination, were found to consist of a crude oil, sp. gr. 0·907 at 15° C., and a rectified oil, sp. gr. 0·909 at 18° C., both of which gave a strong eucalyptol reaction with hydrobromic acid, but no phellandrene could be detected. In addition there was some "residue from the rectification," which appeared to be the portion of the oil having the highest boiling point (boiling between 220° and 260° C.). This fraction, which is a brown liquid, and has a sp. gr. of 0·945, is said to be sought after in Australia as a soap perfume. Its odour is said to strongly resemble cuminol, the presence in it of which body has been detected.

E. odorata, Behr., is mentioned by Maiden‡ as being found

* Pharm. Journ. of Australia, 13th March, 1892.

† Schimmel, Bericht., Oct., 1889.

‡ Useful Native plants of Australia.

in South Australia, Victoria and New South Wales. Mueller found in 1000 lbs. of branches with about 500 lbs. of leaves, 112½ ozs. of essential oil. Bosisto states that 100 lbs. of leaves from trees in elevated situations yielded 4 ozs. 13 drs. of an oil of sp. gr. 0·922, while the yield from the same quantity of leaves in low, swampy situations was only 5½ drs. of oil with sp. gr. 0·899. It is bright yellow in colour with a greenish shimmer and an aromatic camphoraceous taste. Boiling point between 157°-199° C.

E. Planchoniana, Mueller. This species is of limited occurrence and found in northern New South Wales and southern Queensland. The odour of this oil is described as peculiar, allied to citronella, but differing from it. Fresh leaves yield, according to Staiger, 0·06 per cent. Sp. gr. 0·915. It has been suggested as a soap perfume.

E. salubris, "The fluted or gimlet gum," so called in allusion to the appearance of the stem. The extraordinary abundance of oil in the leaves, approximately 4 per cent. in the fresh foliage, points this species out as the leading one in Western Australia for oil distillation.* Maiden makes no mention of its properties.

E. leucoxylon, Mueller. Known in various localities as "Boxwood" or "Mountain Ash" (from some distant resemblance to the appearance of the European Mountain Ash), forms a large tree in the forests on the mountains in the south and east of Victoria. It is also found in New South Wales, Queensland, and in South Australia, near Spencer's Gulf. Bosisto states the yield of oil from 100 lbs. of leaves to be 16 ozs. 7 drs., or over 1 per cent., but observes that the leaves were heated and part of the oil was lost. Sp. gr. 0·923, boiling point 155°-178° C. Odour and taste are said to resemble those of oil of *E. oleosa* (above referred to as *E. cnerifolia*).

E. longifolia, Link., is found in New South Wales to Port Jackson, and in Victoria, the eastern part of Gipp's Land. The oil is said to have an aromatic, cooling taste, and ethereal camphoraceous odour. Sp. gr. 0·940, boiling point 194°-215° C. According to Maiden the yield from 100 lbs. of leaves that had suffered in transport amounted to 3 ozs. 3½ drs. Bosisto considers

* Mueller, Forest Resources of West Australia.

the high sp. gr. may be accounted for by some peculiar substance dissolved in the sample tested, especially as the sample is remarked upon as being viscid, and like a fatty oil left a stain on paper.

E. obliqua, L'Heritier vel *robusta*, *E. fabrorum*, Schl., *E. gigantea*, J. Hook,* commonly known as "The Stringy Bark." It is found growing on very poor soil and at considerable elevations in all the mountainous districts of Tasmania, also in Victoria, southern coast of New South Wales, and South Australia, where it forms vast forests. It is a very fine tree, of an average height of 150 feet, but specimens of 300 and 400 feet in height are not uncommon. Its close-grained wood is used for many purposes, being only slightly inferior to that of *E. globulus*, and the bark is useful for the manufacture of paper. Its foliage has a bluish tint like that of *E. globulus*, the essential oil of which is described (Wittstein and Mueller) as being of a reddish-yellow colour, mild odour, and bitter taste. Sp. gr. 0·899 ; boiling point 171°-195° C.

The eucalypts yielding *Kino* are :—

E. rostrata, Schlecht.
E. calophylla, R. Brown.
E. corymbosa, Smith.
E. maculata, Hooker.
E. tesselaris, Mueller.
E. siderophloia, Benth.
E. amygdalina, Labil.
E. Piperita, Smith.

Though most abundantly found in the Australian continent and its neighbourhood, many of the various species of eucalyptus are found to thrive under very different influences as regards climate and soil. Several have been introduced into India, and are thriving admirably, some being grown at elevations where snow remains on the ground for several months of the year; others flourish best in the northern and warmer parts of the continent; others again, are more at home in swampy ground, whilst some seem to prefer sandy or calcareous soils. The experimental cultivation of gum-trees in other countries must therefore be

* Flor. Austr., iii., p. 204.

regulated by a consideration of these facts. As regards Eucalyptus cultivation in India, the most successful results have been obtained on the Nilghiris, where, according to a recent Report of the Conservator of Forests, South Circle, Madras, there are several extensive plantations, both Government and private, of several species, but chiefly the E. globulus is cultivated on most of the hills in Southern India at from 4,000 to 8,000 feet. Also in Wynaad several varieties have been introduced from Queensland and are growing vigorously. Some trees planted in 1884 were over 60 feet high in 1890, with a girth of 42 inches at 4 feet from the ground.

In Northern India, extensive trials were made in 1876 with seeds of various kinds of Eucalyptus, and it was then ascertained that those of the *E. resinifera* (Smith), and *E. rostrata* (Schlech), were the most promising for cultivation in the plains. These two species have since maintained their character, and there are now several vigorous specimens both at Saharanpur and Lucknow which yield seed abundantly.* The localities in Northern India best suited for the blue-gum (E. globulus) are Ranikhet and Abbottabad. *E. citriodora* (Hooker), and *E. melliodora* (Cunningham), both having sweet-sented foliage, are thriving well in many places in North India.

The author of "The Economic Products of India" says :—"The following communication was received from the Conservator of Forests, Punjaub, in August, 1889 :—"A considerable number of species of Eucalyptus have been tried in various parts of the Province, and on the whole, the results have been satisfactory ; it has been found, however, that planting in groves gives a better chance of success than when the trees are grown singly along roads, &c. In Kangra, in the Kathala estate, and in Kulu, a few specimens of the blue gum and some other kinds have done well, and experiments are now being made in the Dera Tahsil. In Hazara the experiments have been successful, and there are now a number of trees round Abbottabad 80 feet high. In Chamba attempts were made at Kalatop, Chamba and Bakloh ; at the two former places they failed, but there are about 100 trees flourishing at Bakloh. The most extensive experiments that have been made were in the Lahore District at Changa Manga and in the Carob

Watt. Dict. of the Economic prod. of India, iii., p. 279.

plantation at Lahore. In all 25 species have been tried, but out of these, only three, *E. rostrata, E. citriodora* and *E. resinifera,* have had any real success. The cause of the failure may be mainly attributed to three sources—1st, failure in the rains ; 2nd, injury to the young stems by sunburn ; 3rd, and worst of all, the white ants which attacked the tree by eating away the supporting roots."

The commercial situation of Eucalyptus oils generally, now (Nov., 1893) appears to be in a rather critical state, owing to over-production.

Spikenard and Valerian.

In Northern India the ancient Spikenard was long supposed by Europeans to be derived from *Andropogon Schœnanthus,* Lin.,* and in Southern India the name "jatamansi," the name of the true spikenard, has been erroneously applied to tubers of the *Cyperus stoloniferus* Retz, and other sweet-smelling species of the genus *Cyperus* (which have also been designated "sumbul"). Persian and Arabian writers mention Spikenard as "Sumbul," "Sumbul-ul-teeb," "Sumbul-ul-Hind," or "Sumbul-i-Hindi," the latter term being used to distinguish it from Valerian, which is sometimes called "Sumbul"; in fact the words "Nard" and "Sumbul" have been very indiscriminately applied. The word Nard is Persian, and the Persians, as the overland carriers of jatamansi between India and Kirman, and Gerrha and Mesopotamia, communicated their name for it to the Hebrews (Nērd), the Greeks (*νάρδος*) and the Romans (Nardum). It is probable that the Persians modified the word into their language from the Sanskrit word "Naladwitha." The present Syrian and Arabic appellations simply mean "Spike" or "Indian Spike" (*Shebáltá sunbul*).

The drug is now identified with the product known in the dialects of Bombay and Bengal (also in the Tamil vernacular with somewhat different pronounciation) as *játámánsi.* It is known in Hindee as *Balchar* and *Chhar,* but the pronounciation of such

* Blane, in Phil. Trans., lxxx., p. 284.

words cannot be made intelligible by our Western alphabets. The *játámánsi, Mansi, Bhutakesi* ("Demon's hair"), *Pisitá, Tapasvini* and *Mishi,* applied to this root, are all of Sanskrit origin and date from a very remote period. Royle says (Illustrations of the Botany of the Himalayan Mountains, p. 241) "On consulting Avicenna we are referred from the Greek word Narden to Sumbul and from the Latin translation "Nardum" to "Spica," under which, the Roman, the Mountain, the Indian and Syrian kinds are mentioned and "Senbel" is given as the synonymous Arabic name. This proves that "Sumbul" in Persian dictionaries translated "the Hyacinth," —the Spikenard, to which the hair of a woman is compared,—an ear of corn, etc., was always considered by Arabian authors as synonymous with the Nardos of the Greeks. On consulting the Persian works on Materia Medica in use in India, and especially the Mukhzun-ul-Udwieh, we are referred from "Narden" in the Index to "Sumbul" in the body of the work. Under this name, however, four separate articles are described: 1st—Sumbul-hindee; 2nd—Sumbul-roomee, called also "Sumbul-ukletee" and "Nardum-ukletee," evidently the ναρδος χελτιχή of Dioscorides,—said also to be called "Sumbul-italioon," that is, th Nard which grows in Italy; 3rd—"Sumbul-jiballee" or Mountain Nard (ναρδος ορεινή); 4th—"Sumbul farsee," which is a bulbous plant and probably a kind of hyacinth. *Polyanthes tuberosa* is described as being one of the kinds of Persian Sumbul." The Sanskrit name "Balchur" has reference to its resemblance to locks of hair.

The plant which produces the "True Spikenard," "Indian Nard" or "Mountain Nard" of Dioscorides (i., cap. vi.) has been proved beyond all doubt to be the *Nardostachys Jatamansi* of De Candolle, and is botanically described and figured by him in his Seventh Memoir, "Sur la famille des Valerianées," t. 1; and Prodomus, iv., p. 624; also Chatin, "Etude sur les Valerianées" (Paris, 1872), p. 69, t. 2. *N. grandiflora,* D.C., Mem., l. c. p. 8, t. 2, Prodr., iv., p. 624; Wall. Pl., As. Rar., iii., p. 40. *Patrinia Jatamansi,* Don Prodr., p. 159, and in Lambert, "Description of the genus Cinchona," p. 177, with fig. *Valeriana Jatamansi,* Wall. Cat., 431 (not of Jones or Roxburgh, in As. Res., ii., p. 405 and iv., p. 433, which represent *V. Wallichii,* D.C., a plant which is considered identical with *V. Hardwickii,* Wallich); also *Fedia grandiflora,* Wall. Cat., 1187.

The general character of the genus *Nardostachys*, D.C., is described in "Hooker's Flora of British India," iii., p. 210, in the following terms:—"Erect perennial herbs. Leaves entire, radical

NARDOSTACHYS JATAMANSI, D.C.
(Reduced from De Candolle's "Memoir" here quoted).
Plate i. in same.

elongate spathulate; cauline few. Flowers capitate, heads in cymes; bractes oblong, free or nearly so. Calyx-limb, 5-lobed, in fruit enlarged, membranous, veined. Corolla tubular-campanulate,

base sub-equal; lobes, 5, spreading. Stamens, 4. Ovary 3-celled, one ovuled; style linear, stigma capitate. Fruit obovate, compressed, 3-celled, 1-seeded, the 2 barren cells smaller than the fertile. Seed obovate, compressed."

The distinctive character of the species *N. jatamansi*, is detailed by the same authority, as follows:—"Root stock, woody, long, stout, covered with fibres from the petioles of withered leaves. Stem, 4 to 24 inches, more or less pubescent upwards,

NARDOSTACHYS GRANDIFLORA, D.C.
Reduced from Plate ii. in De Candolle's 'Memoir' here quoted.

often glabrate below. Radical leaves, 6 to 8 inches by one inch, longitudinally nerved, glabrous or slightly pubescent, narrowed into the petiole; cauline, 1 or 2 pairs, 1 to 3 inches long, sessile, oblong or sub-ovate. Flower heads usually 1, 3 or 5; bractes, $\frac{1}{4}$ inch, oblong, usually pubescent; corolla tube, $\frac{1}{4}$ inch long, somewhat hairy within, as are the filaments below. Fruit, $\frac{1}{6}$ inch long, covered with ascending white hairs, crowned by the ovate, acute, often dentate calyx-teeth. There are two forms of this plant; a *large-flowered* (see illustration on preceding page), with usually glabrous bractes, and a smaller one, with the corolla tube scarcely $\frac{1}{6}$ inch long, and the bractes densely, shortly hairy; various intermediate forms occur."

The plant is found in the Alpine Himalaya, at altitudes of 11,000 to 15,000 feet; from Kumaon to Sikkim, ascending to 17,000 feet in Sikkim.

N. jatamansi is a plant of easy cultivation, in the open air, in this country. A specimen supplied to me from Messrs. Ware and Sons Nurseries, at Tottenham, agrees with tab. i. in De Candolle's Mémoire, above given. The plant is quite hardy in England.

With regard to the objection that the fragrance of the Jatamansi is not such as to warrant the probability of its having been so highly esteemed by the ancients, Royle observes that it might be sufficient to reply, that it is both incorrect and unphilosophical to infer that the tastes of another time and country must be those of the age and place we live in. In the present instance, however disagreeable it may be to some, there is no doubt that the jatamansi is highly esteemed in the present day throughout the East, both as a perfume and a stimulent medicine.

The part of the plant which is collected for the market is the perennial, hairy portion of the stem immediately above the root.*

Dr. Dymock says†:—"It is very desirable that further trials

* The hair wash in common use among Indian women and called *Angalepan*, *Angodvartan*, *Sughandi-puri* or *Utnen*, is composed of Gávala (seed of *Prunus Mahalib*); *Kápûrkachri* (*Hedychium spicatum*, which see); *Vala* (*Andropogon Muricatus*, see 1st Series); *Pách* (Pogostemon Patchouli); *Jatamansi; Upalét* (*Aplotaxis Lappa* "Costus"); *Nágarmoth* (*Cyperus scariosus*, which see). (*C. pertenuis* is sometimes used); *Dauna* (*Artemisia sieversiana*) and *Murwa* (*Origanum*, several species). Other articles are sometimes added.

† Mat. Med. W. Ind., 2nd ed., p. 347; Notes on "Indian Drugs," Pharm. Journ. [3], ix., p. 1034.

should be instituted with this promising drug, which can be procured at a small cost in almost all the bazaars throughout India (½ Re. per pound). Care should be taken to select good specimens for trial, as the central portion of the root is often destroyed by insects."

The drug, as brought from the mountainous districts of Northern India, consists of a short portion of rhizome, about as thick as the little finger, of a dark grey colour, surmounted by a bundle of fine reddish-brown fibres, the whole forming an object of peculiar bristly appearance, not unlike the tail of a sable or marten. The fibres are produced by an accumulation of the fibrous tissue of former leaves, and are matted together, forming a kind of network; amongst them the remains of flower-stalks may be found. The odour of the drug is heavy and peculiar, like a mixture of valerian and patchouli, although more agreeable than either; the taste is bitter and aromatic. When the central portion is removed and cut across, it is seen to consist of a thin cortical portion connected with the central woody column by four medullary bands, between which are situated large canals, which contain the fibrovascular bundles. The central woody column is of a red-brown colour, angular and jointed, having a certain amount of resemblance to the vertebræ in the tail of an animal.

The *product* "Spikenard," discussed by Sir William Jones (As. Res., ii., p. 405), was doubtless derived from Nardostachys, but the plant described and figured as *Valeriana Jatamansi* is *Valeriana Wallichii*, D.C. The mistake arose from the fact that he was supplied, either accidentally or by design, with the wrong plant from Bhutan, and this at a time when it was not possible to detect the imposture, as it was long before we had free access to the hills. The same mistake seems to have been made by Roxburgh, in the Asiatic Researches, iv., p. 433, and was subsequently corrected by Wallich and Royle independently. The name *V. Jatamansi* is hence to be suppressed.

Jatamansi was investigated by Kemp in 1884, with the result that* 56 lbs. of the root yielded, on distillation, three fluid ounces of oil. Its optical power was —19° 5′ in 100 m. m. tube. Its sp. gr. at 82 Fahr. was 0·9748. One hundred pounds of the

* Dymock, Pharmacographia Indica, ii., p. 237.

root submitted to distillation by Kemp & Co. (1890)* yielded fifteen ounces of a pale yellow oil and a faintly acid distillate.† "A fine violet or bluish colour is produced, as with oil of valerian, by mixing a drop or two of the oil with about 20 drops of carbon disulphide and a drop of strong nitric acid. With sulphuric acid the oil gives a reddish-brown coloration. On boiling, the oil acquires a darker hue and a greenish fluorescence."

Valeriana Wallichii, D.C., Mem. Valer., p. 15, t. 4; D.C. prodr., iv., 640; Wall. Pl. As. Rar., iii., 40; Syn. *V. villosa*, Wall. Cat., 433; *V. Jatamansi*, Jones, in As. Res., ii., fig. at p. 405; Roxb. in As. Res., iv., p. 433; Fl. Ind., i., 163 (see Royle, Ill., p. 243, correcting Jones and Roxburgh's mistake); *V. spica*, Vahl. Enum., ii., p. 13, is an inhabitant of the temperate Himalaya, from Kashmir to Bhotan at altitudes of 10,000 feet, and the Khasia mountains at altitudes of 4,000 feet, and is distributed in Afghanistan. As described in Hooker's Flora of British India, iii., p. 213, "the root-stock is horizontal, thick, with thick descending fibres. Stem 6 to 18 inches, often decumbent below, very rarely divided. Radical leaves often 1 to 3 inches diameter, deeply cordate, usually acute and toothed. Corymb 1 to 3 inches in diameter, not very lax even in fruit; bracteoles oblong-linear, as long as the fruit. The typical large form of this, with acute, toothed radical leaves and pilose fruits, is easily separable from *V. pyrolæfolia*; but there are smaller examples, with the radical leaves elliptic, entire, the fruits nearly glabrous, which are very near *V. pyrolæfolia*.

It does not appear to be a proven fact that *V. Wallichii* D. C., is a distinct species from *V. Hardwickii* of Wallich and Don‡ (Wallich's post-scriptum observation to this last description by Roxburgh is worded thus:—"The flowers and seeds seem like those of *V. Jatamansi*, but in regard to the root and leaves the two plants differ widely." It is also to be remarked that Don avers the *V. Hardwickii* to be the plant described and figured by Sir William Jones as spikenard in the Asiatic Researches, ii., p. 403, which description and figure is above accounted for as pertaining

* Dymock, Pharmacographia Indica, ii., p. 237.

† It is presumed they mean the aqueous portion of the distillate.

‡ Hardw. in As. Res. vi., p. 350, with a figure; Don. Prodr. Fl. Nep., p. 159; Wall. Pl. As. Rar., iii, t. 263; Roxb. Fl. Ind. i., p. 166.

to *V. Wallichii* D.C.; yet De Candolle expressed the opinion that the two plants were of distinct species* ; but Lindley (Flor. Med., 472) in speaking of De Candolle's opinion expressed about another

VALERIANA WALLICHII.
Reduced from Plate iv. in De Candolle's 'Memoir' here quoted.

species (*V. Dioscoridis*) says, " . . . . the learned botanist was not personally acquainted with the subject."

* D. C., Mem., Val., p. 16.

The figures given by Royle (Illust. Bot. Himal., t. 54) of *Nardostachys Jatamansi* are reproduced in Figure annexed. Comparing them with De Candolle's representation of that plant (D. C. Mém. Valer), on preceding page, a striking difference is apparent;

Nardostachys Jatamansi, Royle.

several parts of Royle's plant, especially the leaf formation, approximating in appearance to those of *V. Celtica* and *V. Saliunca*, and the lower portions to those of *V. Gangites** or "False Indian

* Guibourt, Hist. des Drogues, iii., p. 73.

Nard" which Chatin* calls the "Faux Nard Radicant," and *Nardus Celtica* or "False Celtic Nard."† Nevertheless, Royle's figures are considered by eminent botanists of the present day to represent a form of the true plant, though perhaps not correct in all details. The extreme forms of Nardostachys differ considerably but they are connected by intermediate varieties. Also the plant has a very different appearance at different stages of its growth. The particular plants illustrated by Royle were possibly not so judiciously selected as a pure type of the true plant as the example figured by the more experienced botanist, De Candolle. Royle's plants may have been more mature as regards the root (which he says is crowned by the bases of several stems in the larger plant), and may have been taken early in the year, before the full development of the leaves.

Considering the acknowledged mistakes, differences of opinion, etc., amongst various writers, to say nothing of the confusion of vernacular names, and the vague ideas conveyed in the writings of the Ancients, the subject is a very difficult one.

Dioscorides (i., cap. 6) distinctly mentions three kinds of Nard: the "Celtic," the "Mountain" (now taken to be the *N. Jatamansi*, D.C.), and the third being of two varieties, the "Syrian" and the "Indian." The latter is also called "Gangites," from the river Ganges, near which, flowing by a mountain, it is found. This plant is in all its parts larger than the mountain plant, and has several hairy spikes growing out of one root; these are rather dark in colour when dry, and smell something like Cyperus roots. It is considered that this plant furnishes what is known as the "False Indian Nard." There are two sorts of the root of this plant met with in commerce, the one termed "radicant" and the other "feuillu." The last is gathered in a younger state of the plant and consists of a spike covered with yellow foliations, or the remnants of the petioles of withered leaves, terminating in a short, ligneous root furnished with yellowish, fibrous rootlets. As the plant ages the remnants of leaf formation decompose and assume the form of hairy filaments.

Dr. Dymock (Pharmacographia Indica, ii., p. 238) states that the dried root of *V. Wallchii*, D.C., furnishes the Indian perfume

* Etudes sur les Valerianées, p. 130, t. iii., B.

† Ibid. p. 141, t. xi.

known in Hindee and Bengalee as *Tagar*, in Punjab dialect as *Mushk-i-Wali*, also as *Bala*, and in the district of Bhutan as as *Pampe*. He states that this fragrant drug, *Tagara*, is frequently mentioned by Sanskrit writers, and other names for it are *Nandyavárta*, *Nundini*, *Varpini*, *Nadhushakhya* and *Pinditagara*.

The value of the dried root in India is stated to be 7 Rs. per Surat maund of 37½ lbs. Other plants of the same genus possess odorous properties.

Valeriana Celtica, Lin., Spec., p. 46; Jacquin Collectanea ad Botanicam, i., t. 24, f. 1, the "Celtic Nard," is a hardy perennial, a native of the Swiss Alps and the Tyrol,—the country of the ancient Celts. The plant is glabrous, the leaves quite entire, obtuse; the radical ones obovate; the cauline ones linear. The stems are simple, two to 3 inches high; the flowers disposed in interrupted racemose spikes, white inside, reddish outside; the fruit hairy. The roots are black, sweet-scented and highly prized by Eastern nations for the purpose of aromatising their baths. These roots are collected by the Styrian peasants with no slight difficulty and labour, and are exported by way of Trieste to Turkey and Egypt, whence they are conveyed to India and Ethiopia.

The odour of essential oil of Styrian *Valeriana Celtica* is very powerful, resembling a mixture of Roman Chamomile oil and, Patchouli. Its sp. gr. at 15° C. is 0·967. It boils at from 250° to 300° C. The root, as met with in trade, is usually weighted with 80 per cent. of earth adherent to its fine fibres; and is frequently adulterated with roots of *Valeriana sexatilis*, found in the same localities, and a false Nard with a fibrous surface much resembling the true *N. Jatamansi*. The yield of essential oil from the roots of V. Celtica (when freed from the adherent earth) is 1 per cent.

Valeriana sexatilis, Lin., Spec., p. 45; Jacquin, Floræ Austriacæ Icones, iii., t. 267; Jacquin, Hortus botanicus vindobonensis, p. 204; D. C. Flore Française, iv., No. 3324; Bertolini, Amœnitates Italicæ, p. 326; Krocker, Flora Selesiaca renovate, No. 52, t. 6; Plukenett, Phytographia, t. 232, f. 2.* This also is a hardy perennial, native of the Alps, Austria and Italy and found in the same regions as *V. Celtica*, as on the high mountains of Mont

* See also Chatin, "Etudes sur les Valerianées"– Thèse pour le Doctorat en Médecine, Paris, 1871.

Genèvre, etc., and like this last, has a dark-coloured, very sweet-scented root, which, when chewed, leaves a bitterness on the tongue. The radical leaves are on long petioles, elliptic, 3 to 5 nerved, undivided or a little toothed, ciliated; cauline leaves few, small, linear; stems erect; corymbs racemose; flowers white, often diœco-polygamous, fruit glabrous. The whole plant is shining and about half a foot high, with the stems sub-divided at top. Analogous to this and to *V. Celtica* in perfume is :—

V. Saliunca, Allioni, Flora Pedemontana, i., p. 3, t. 70, f. i.; Dufresne, Hist. Nat. de la famille des Valerianées, p. 47; *V. supina*, D.C., Flor. Française, iv., No. 3323; *V. Celtica*, Villars, Hist. des plantes du Dauphiné, ii., p. 285. A perennial, native of Savoy, Vallais, Piedmont, Dauphiné, Italy, on the higher Alps. The plant is glabrous; leaves spathulate, obtuse, entire, on short petioles; cauline leaves sometimes tridentate at the base, stems short. The flowers, which are disposed in capitate corymbs, are white, tinged with red and sweet scented. The fruit is oblong and glabrous. The root is sweet-scented and of bitter taste. The plant is from 3 to 6 inches in height.

Valeriana Dioscoridis. According to Sibthorp & Smith,* this is the true *Valeriana Phu*, *φοῦ*, of Dioscorides and therefore the most powerful of the Valerians, for which *V. officinalis* is to be considered merely the the Northern substitute; It has a much more aromatic and less nauseous odour than the British species. De Candolle refers this species to *V. sisymbriifolia* of Desfontaines, an oriental plant; but the synonymy does not appear to be certain. Its Persian name is Bekh-i-sumbul.

V. Dioscoridis is a native of the country about the river Limysus in Lycia. The root consists of several fleshy, fusiform tubers. The stem is erect, rising to a height of two feet; it is simple, leafy, taper and hollow. Radical leaves numerous, petiolate, lyrate, pinnated; the leaflets opposite, sessile, ovate, with spreading teeth and veiny, the odd one very large. Stem leaves few, opposite, sessile, pinnated, the leaflets nearly equal, lanceolate, unequally toothed. Cyme terminal, trichotomous, many-flowered, thyrsoid. Bractes lanceolate, acuminate. Flowers flesh-coloured.

* Floræ Græcæ, i., p. 24, t. 33.

Corolla funnel-shaped, not spurred, with a nearly regular limb. Stamens 3, equal; anthers yellowish. Stigma simple. Fruit keeled on the outside, 3-ribbed on the inside, rather downy, with a radiant feathery pappus.

False Nard of Dauphiné is the result of a peculiar bulbous formation of *Victorialis longa*, Clusius*; *Allium anguinum*, Matthiolus, also of Bauhin.† It is the "Anglio serpentino" of the Italians and the *Allium longum* of pharmacists. Pomet's description of it is imperfect.

In outward appearance it resembles the *Nardostachys Jatamansi* being of about the same thickness and length as the little finger, rather thicker in the centre than at the extremities, but of a greyish mouse-colour, odourless and tasteless, or simply *earthy* in those respects. Its outer surface is uniform in appearance, the very fine fibres composing its coating forming an evenly lozenge-shaped branchlet or spike. The longitudinal section exhibits that the formation of the white, round, cellular body of this root is successively upwards in its habit of growth, the most recent growths being at the summit and the oldest at the base, a reddish brown horizontal line demarcating the position of the bulbs of previous consecutive years. At the summit of the uppermost bulb is the germ of the one which will form in the next year, and below are the débris of bulbs of preceding years; the whole being enveloped in a hairy formation resulting from previous growths, and forming a sort of prolonged sheath from the bottom upwards, a manner of growth quite the reverse to that of roots of other species of *Allium*.

This false Nard is collected at Lantaret, on Mont Genèvre and other mountains of Dauphiné, the Pyrenees, the Jura and Auvergne, also on the mountains in Switzerland, Italy, Austria and Silesia.

"Nobel's Celtic Nard" is the root of *Arnica montana*, Lin. (*compositæ*).

"Italian Nard"; "Nardus Italica" of Matthiolus and of Lobel; "Nardus germanica" of Lonicer; "Nardus Aspic," or French Nard, is the oil of *Lavandula spica* (*Labiatæ*).

* Rariorum Plantarum, p. 189.

† Historia Plantarum, p. 422.

"Mountain Nard" is a name attributed to the roots of *Valeriana pyrenaïca,* Lin., *V. tuberosa,* Lin., and *V. asarifolia,* Dufresne.

"Cretan Nard"; "Nardus Cretica" of Belli, Prosper Alpinius and others is derived from *Valeriana Phu,* Lin.

"Nard Sauvage or Wild Nard" (employed medicinally as an emetic) is furnished by *Asarum Europæum,* Lin.

"Assyrian Nard" and "Nard de la Madeleine" are names given to the "Indian Nard" *N. Jatamansi.*

"Spanish Nard" is produced by *Valeriana Tuberosa,* common in the south of Europe, Spain and the Caucasus.

"False Nard of Narbonne" is a name given by Daléchamps to the False Nard of Dauphiné.

The writer of the article "Spikenard" in the Encyclopædia Britannica, states that this celebrated perfume seems to have formed one of the most durable aromatic ingredients in the costly unguents used by the Roman and Eastern nations. "The ointment prepared from it—"Ointment of Pictic Nard"—is mentioned in the New Testament* as being very costly, a pound of it being valued at over 300 denarii (over £10). This appears to represent the prices then current for the best quality of Nard, since Pliny mentions that Nard spikes reached as much as 100 denarii per lb., and although he does not mention the price of the Nard ointment, he states that the *Unguentum cinnamominum,* a similar preparation, ranged from 25 to 300 denarii according to its quality.† Nard ointment also varied considerably in price from its liability to sophistication.‡

On the authority of Pliny,§ the ingredients of the genuine ointment, "*Unguentum nardinum*" were as follows :—

"Indian Nard"—now known as *Nardostachys Jatamansi,* D.C.

"Juncus"—probably the leaves of *Andropogon Lanigerum,* Desfontaines.||

"Costus"—the root of *Aplotaxis Lappa,* Decaisne.¶

* Mark xiv., 3-5; John xii., 3-5.

† Pliny, Hist. Nat., xii., 26, and xiii, 2.

‡ Idem. xii., 26, 27; xiii. 2.

§ Ibid xiii., 2.

|| Vide 1st Series, p. 311.

¶ Ibid, p. 110.

"Amomum"—the fruits of *Amomum Cardamum*, L.

"Myrrh"—the gum-resin of *Balsamodendron Myrrha*, Nees.*

"Balm"—The oleo-resin of *Balsamodendron Opobalsamum*, Kunth and Brandis.†

"Omphacium" or "Oleum Omphacium"—the oil expressed from unripe olives.

"Balaninum"—probably derived from *Balanites Ægyptiaca* (which see).

"Malabathrum"—the leaf of Cinnamomum Tamala, Nees, was, according to Dioscorides (i., 75), sometimes added.

As is the case generally in hot climates, oil was used by the Jews for anointing the body after the bath, and giving to the skin and hair a smooth and comely appearance before an entertainment.‡ Strabo says the inhabitants of Mesopotamia use oil of sesame, also castor oil. At Egyptian entertainments, it was usual for a slave to anoint the head of each guest as he took his place, castor oil being sometimes used; Egyptian paintings represent this custom. The Greek and Roman usage will be found mentioned frequently by Homer, Horace and Pliny, showing that it was customary at banquets to honour the guests by pouring costly perfumed oils over their feet.

Athenæus speaks of the extravagance of Antiochus Epiphanes in the matter of ointments for guests.§

Creech, in his annotations on Lucretius,|| says:—"Moreover they arrived at length to an excess of curiosity in regard to their ointments that was indeed wonderful; for Athenæus¶ reports that, 'They grew so nice as to require several sorts of ointment for one single unction, viz., Egyptian for the feet and thighs, Phœnician for the cheeks and breasts, Sisymbryan for the arms, Amarantine for the eye-brows and hair, and Serpylline for the neck and knees.'" But above all the rest we may observe that the ancients made use of one sort of oil or ointment of great value and singular excellency; it was called *Oleum Susinum*, and

* Vide 1st Series, p. 268.

† Ibid, 270.

‡ Ruth, iii., 3; Prov. xxvii., 9, 16; Cant. i., 3, iv., 10.

§ Wilkinson, Ancient Egypt, p. 78.

|| Lib. iv., 1123.

¶ Lib. xv. cap. 2.

made from lilies, which, in the Phrygian tongue were called σύσα, but chiefly of that sort of lily which the Greeks call χείνον, and to which it is believed allusion is made in Canticles v. 13, where the Church says of Christ, "His lips are like lilies." Pliny describes the lily that is called χεινον to be of a ruddy colour.* Elsewhere† he says:—"'Oleum Susinum' was made of oil of Ben (a colourless, tasteless and inodorous oil expressed from the seeds of *Moringa pterosperma*, now naturalised in the West Indies, an oil which never becomes rancid and does not corrode steel), roses, honey, saffron, cinnamon and myrrh." The amount of perfume used in the palmy days of Rome was enormous; the wealthy patricians were most prodigal in this respect. The perfumers were called "*Unguentarii*," as they principally compounded unguents, and must have done an immense business. In Rome they congregated in a quarter called "*Vicus Thurarius*." The most celebrated perfumer in the time of Martial was a certain individual called Cosmus, whom Martial frequently mentions. At Capua there was such a number of perfumers that the principal street of the city, named Séplasia, was almost entirely occupied with them. For the most part, these tradesmen were Greeks, and, as at Athens, their shops (*taberna*) were the rendezvous of the rich idlers of that period. The perfumed oils and ointments were made in great variety. The basis of the oils was generally the oil of Ben, above-mentioned, and that of the unguents was a bleached and partly purified tallow.

Some of these were simple oils, such as *Rhodium*, made from roses; *Narcissum*, from the narcissus; *Melinum*, from quinces; *Metopium*, from bitter almonds. Perhaps the most fashionable oil, after the *Oleum susinum* above-mentioned, was that called *Crocinum*, made from Saffron, which communicated both a fine colour and odour to the person.‡ Butter is noticed by Pliny as used

* Pliny, Nat. Hist., lib. xxi., cap. 5.

† Ibid., xiii., 2.

‡ The use of alabaster vessels for preserving these fragrant unguents was customary at a very early period. Theophrastus (circa., 314 B.C.) states that vessels of lead and alabaster were best for the purpose, on account of their density and coolness, and their power of resisting the penetration of the ointment into their substance. Pliny also recommends alabaster for ointment vases. For small quantities onyx vessels seem to have been used (Horace, Carm., iv., 12).

by the negroes and lower classes of Arabs for anointing their bodies. The natives of India prefer strong perfumes for this purpose, and use oil of santal and oil of patchouli.

The principal use of spikenard at the present time, in the East, is for making hair washes and ointment; the popular opinion being that it promotes the growth and blackness of the hair.

Two Valerians are natives of this country. **V. officinalis**, Lin., is the most common; it has erect stems two to four feet high, irregularly pinnated leaves, and small white or pink flowers in broad, terminal corymbs. It is usually found in moist hedge-rows or on the banks of ditches and streams.* **V. dioica** is a native of bogs and marshes, has stems not attaining to a height of more than six or eight inches; the lower leaves are ovate-entire, the upper ones pinnate, with one large segment at the end; the flowers are small, unisexual. **V. pyrenaica**, occasionally found wild, is a larger plant than the common Valerian, from which also it may be known by its heart-shaped, toothed leaves. Several other species are grown in gardens, many of them handsome, flowering plants.

The roots of freshly-gathered *V. officinalis* are inodorous, but on drying they acquire a characteristic peculiar odour, penetrating and fetid, somewhat terebinthinate and camphoraceous. Its taste is bitter and aromatic. The dried root contains 0·50 to 2 per cent of volatile oil; this variation is partly attributable to the influence of the soil in which the plant was grown; a dry, stony soil produces roots which are richer in essential oil than roots grown in a humid fertile soil.

Mexican Valerian. This variety is described† by R. McLauglin as a beautiful herbaceous plant, common in the woods and damp places of Eastern Mexico. The roots as found in the Mexican Markets, occur in slices or fleshy discs from half to one and a half inch in diameter, or sometimes in entire tubers. These are very large, greyish externally, yellowish internally, hard and tough. They have a granular fracture when dry, and possess an unpleasant odour and bitter taste. On analysis a specimen was found to yield volatile oil, 3·33 per cent.; oleo-resin, 4·30; wax

* For figure of the plant see Bentley and Trimen's Med. Plants., t. 146.

† Am. Journ. Pharm., lxv., p. 329.

and fat, 1·09; valerianic acid, 0·91; mucilage, 4·50; pectin, 1·35. There are also distinct quantities of a glucoside separated in a crystalline condition, on pouring a concentrated alcoholic extract of the drug into acidulated water, and agitating the clear filtrate with ether. The commercial European valerian yielded similar crystals under the same conditions, although in less quantity. By distilling some of the coarsely powdered Mexican root with water, confirmation was obtained of the large proportion of volatile oil it contained, 3·33 per cent. being the minimum proportion present, apart from that contained in the oleo-resin.

Crude **oil of Valeriana officinalis** is pale yellow or greenish; sp. gr. 0·90 to 0·93. It begins to boil at 200° C., gradually rising to 400° C. The crude oil was found by Pierlot* to consist of *Valerene* $C_5 H_8$, *Valerol* $C_6 H_{10}O$, about 18 per cent. of a stereoptene identical with Dryobanalops camphor $C_{18} H_{10}O$, 7 per cent. of resin, and 5 per cent. of free valerianic acid.

On submitting the crude oil to fractional distillation, a yellowish oil passes over between 120° and 200° C., containing nearly all the valerianic acid and valerene (an isomer of *Borneene*); afterwards there passes over the valerol, or oxygenated constituent. The action of the air converts valerol into valerianic acid (a reaction instantly produced by potassium hydrate); therefore, in eliminating the valerol by distillation, the operation should be conducted in a current of dry carbonic acid.

Valerianic acid, $H C_5 H_9 O_2$, is a limpid, oily, colourless fluid, smelling strongly of valerian root; it has an acid taste and reaction, and leaves a sensation of sweetness and a white spot on the tongue; it is inflammable, boils at 175° C., is freely soluble in alcohol and ether, is soluble in 30 parts of water, and forms salts (valerianates) most of which have a sweetish taste, are soluble and uncrystallisable; sp. gr. 0·937; placed in contact with water, it absorbs a portion of it, and is converted into a terhydrated acid, with increase of sp. gr., and reduction of the boiling point.

Valerianic acid is related to amyl alcohol in the same manner as acetic acid is to ethyl alcohol. It is found in Angelica root; the root of *Athamanta oreoselinum*; the fruit and bark of the Guelder-rose (*Viburnum opulus*); the bark of the Elder tree; and in many

* Ann. Chim. Phys. [3], lvi., p. 291.

plants of the Composite Order. It is also found in many animal oils and other animal secretions. It is a frequent product of the oxidation of fats and of the putrefaction of albuminous substances.

The valerianic acid prepared from valerian root is less commonly employed than the same acid prepared artificially by either of the following processes :—

1. A mixture of fusel oil (hydrated oxide of amyl, called also "oil of potato-spirit, or grain-oil"), with about 10 times its weight of quicklime and potassium hydrate in equal proportions, placed in a glass flask, heated first to 170° C., and the temperature gradually raised to 200° C., and then kept heated for 10 or 12 hours, by means of a bath of oil or fusible metal ; the nearly white solid residuum is mixed with water, an excess of sulphuric acid added to the mixture, and the whole subjected to distillation : the distillate is supersaturated with potash (or the condensed vapour may pass into a receiver containing a solution of carbonate of soda), evaporated nearly to dryness to dissipate any undecomposed potato oil, and then mixed with weak sulphuric acid in excess ; a light oily liquid (terhydrated valerianic acid) separates, which by cautious rectification, yields at first water containing a little acid, and afterwards pure monohydrated valerianic acid, which is perfectly identical with that prepared from valerian root.

2. From sodium valerianate, which is perhaps the most economical process. Dilute 6½ fluid ounces of commercial sulphuric acid with ½ pint of water ; then dissolve 9 ounces potassium dichromate in 3½ pints of water with the aid of heat ; when both solutions have cooled put them into a matrass, and having added 4 fluid ounces of fusel oil, shake them together repeatedly until the temperature, which first rises to 150° Fahr., has fallen to 80° or 90° F.). A condenser being connected, next apply heat so as to distil over about 4 pints of liquid ; saturate this exactly with a pint or q. s. of solution of caustic soda, separate the liquid from the oil which floats upon the surface, and evaporate it until the residual salt is partially liquefied. The heat being now withdrawn, and the salt concreted, this last, whilst still warm is to be immediately divided into fragments and preserved in well stoppered bottles if not intended for immediate use. The valerianic acid can be separated from this salt as described in the

first process, viz., the sodium salt is decomposed by very dilute sulphuric acid, and the monohydrated valerianic acid rectified out by cautious distillation.

The process of oxidation of amyl alcohol has also been described as follows:—One part of amyl alcohol (potato oil) mixed with two parts of strong sulphuric acid is allowed to flow slowly into a solution of five parts potassium dichromate in water, and when the first action, which takes place spontaneously, is over, the mixture is heated for some time in a flask provided with a vertical condenser, in order to convert the *Valeral* (valerianic aldehyde) produced in the first instance, into valerianic acid. The vapours are then allowed to distil over and condense in an ordinary condenser. The distillate is saturated with sodium carbonate; the amyl valerianate contained in it is distilled off, and the dry residue of sodium valerianate is dissolved in an equal weight of water and distilled with sulphuric acid ($\frac{1}{2}$ to $\frac{4}{5}$ part of sulphuric acid to one part of sodium salt). The distillate consists of an aqueous solution of valerianic acid, surmounted by an oily layer consisting of a definite hydrate $C_5 H_{10} O_2, H_2 O$, from which the pure monohydrate, $C_5 H_{10} O_2$, may be obtained by rectification. A milky aqueous distillate passes over at first, and afterwards, at 175° C. the pure acid in the form of an oily liquid.

Although oil of *Valeriana officinalis*, and many compounds obtainable from it are offensive in odour, some of the compounds of valerianic acid are highly fragrant, such as:—*Amyl valerianate* $C_5 H_{11} C_5 H_9 O_2$, a colourless volatile liquid which when diluted with 5 or 6 volumes of alcohol and other ingredients, forms the Apple essence used for flavouring.

Amyl valerianate is abundantly formed during the preparation of valerianic acid from potato oil, and is recognised by the offensive odour of rotten apples evolved during the process. By treating the crude product of the distillation with a weak solution of pure potash, the valerianic acid is removed and the amyl valerianate obtained nearly pure. It can also be obtained by the direct action of valerianic acid on fusel oil. Its fragrance, as above observed, is developed by dilution with alcohol, but in the pure state it is rank. Care should be taken to employ pure potato oil, thoroughly rectified of all impurities, as some impurities (usually present) would be apt to form by oxidation butyric and propionic

acids, and be very detrimental to the true odour of the product required.*

Valeral, or Valerianic aldehyde, $C_5 H_{10} O$. Allow a mixture of 11 parts amyl alcohol, $16\frac{1}{3}$ parts sulphuric acid and $16\frac{1}{3}$ parts water to flow slowly into a lukewarm solution of $12\frac{1}{3}$ parts potassium dichromate, whereby sufficient heat is produced to cause the greater part of the valeral to distil over; towards the end, however, the distillation must be assisted by external heating. The oily layer of the distillate is separated and shaken up, first with potash-ley, to remove valerianic acid formed at the same time, and then with acid sodium sulphite, with which it forms a crystalline compound. The resulting crystals are pressed and washed with alcohol and the valeral is separated therefrom by distillation with sodium carbonate. It is a colourless, very mobile, strongly refracting liquid, having a burning, bitter taste and pungent, fruity odour, exciting coughing when inhaled (as do many of the amyl compounds). Its sp. gr. is 0·8057 at 17° C. and 0·8224 at 0° C.; boiling point 96°-97° C. under ordinary pressure; 92°·8 under a pressure of 740 m. m. (Kopp.). It is very inflammable, burning with a bright flame. Insoluble in water, but mixes in all its proportions in alcohol and volatile oils.

* Fusel Oil is an offensive strong-smelling oil, produced along with alcohol, during the fermentation of grain, potatoes, etc., on the large scale, and which gives the peculiar and disagreeable flavour and odour to raw whiskey. It is found chiefly in the last portion of the spirit which passes over, called the "faints," to which it imparts its characteristic odour and flavour. By rectifying the faints at a very gentle heat, most of the alcohol and water first pass over together with only a little fusel oil, whilst the latter forms the residuum in the still. Various names are given to the crude oil thus obtained, according to its source. In each case it essentially consists of hydrated oxide of amyl, but trifling and variable quantities of other organic compounds are mixed with it, which slightly modify its character, more particularly its odour and flavour. The oil of potato spirit is the purest form of crude fusel oil. It is a nearly colourless, volatile liquid, with a rather high boiling point, a durable, penetrating, offensive smell, and an acrid, burning taste. It may be purified by the following process:—Introduce the ordinary fusel oil of the distilleries into a small still or retort, connected with a condenser, and apply heat; as soon as the oil begins to flow over unmixed with water, the receiver should be changed and the distillation resumed and carried nearly to dryness; the product in the second receiver, and the matter which separates from the water in the first receiver, are to be reserved for use in the preparation of valerianate of soda, etc.

Diethylvaleral, $C_5 H_{10} (C_2 H_5)_2 O_2$. According to Alsberg this is prepared by heating 1 volume of valeral with 4 volumes of alcohol and 1 volume of acetic acid. It is slightly soluble in water, and has a pleasant fruity odour. Its sp. gr. is 0·835 at 12° C. Boiling point 158°·2.

Dimethylvaleral, $C_5 H_{10}(CH_3)_2 O_2$. It is prepared by heating 1 volume of valeral, 2·5 volumes methyl alcohol and 0·5 volume acetic acid. It has an agreeable odour. Its sp. gr. is 0·852 at 10°, and boiling point 124°.

Ethyl valerianate, $C_2 H_5 C_5 H_9 O_2$, is a fragrant, volatile liquid, lighter than water, having a high boiling point and a rich, fruity odour, said to closely resemble that of the butyric ether, or pine-apple. It is prepared by passing dry hydrochloric acid gas into an alcoholic solution of valerianic acid. It is used for flavouring purposes. It can also be prepared by distilling 8 parts of valerianate of soda with 10 parts of 88 per cent. alcohol and 5 parts of concentrated sulphuric acid. Water is added to the distillate in order to separate the ethyl valerianate, which floats on its surface as an oil. This product is washed in a solution of carbonate of soda in pure water, then dried over chloride of calcium and rectified, collecting only the portion distilling at 133 C.° It is a very limpid oil of sp. gr. 0·894 at 13 C.°

The odour of apples has been noticed in the leaves and green parts of certain species of *Rosa*, such as *R. rubiginosa* (sweet-briar) (series i., p. 23), but its nature has not been studied.

A peculiar fruity, apple-like odour is noticed in the juice of the leaves of *Clerodendron inerme*, Gærtn., Fruct., i., t. 57, f. i.; Rheede Hort. Mal., v., t. 49; a straggling bush of 3 to 7 feet in height, native of India and Ceylon, in localities near the sea. The common name in Hindustanee is Sangkupi and Chhoti-arni. It is the *Gambir-laut* of Java, the *Wæl-bu-rænda* of Ceylon, and the *Sanfu-mun* of Cochin-China. The shoots of this shrub are grey-pubescent. Leaves opposite, rarely ternate, ¾ to 1½ in. long; when young, somewhat grey-pubescent, base cuneate; petiole ⅛ inch. Peduncles ½ to 1½ in., axillary, 3-7 fid.; bractes $\frac{1}{30}$ in., linear; pedicels ⅛-⅙ in., calyx grey-puberulous or glabrate. Corolla white, tube ¾ in., glabrate; lobes ⅕ in., oblong. Drupe ½ by ⅓ in., spongy, hardly succulent, smooth, separating into four woody pyrenes. Or the leaves may be mostly ternate or sublinear and larger. The drupe also may vary in size.

The leaves yield, by distillation with water, a stereopten-like body having the fruity odour of the fresh plant. The matter extracted by ether, amounting to 4·77 per cent., is fragrant, green, and of a greasy consistence. Examined by Hooper,* the leaves left, on gentle incineration as much as 15·29 per cent. of ash, which contained a very large amount of salt, thus indicating the habitat of the plant as being in close proximity to the sea.

If the fresh leaves be carefully dried in the shade they preserve their aroma.

Juniper.

Juniperus communis, Lin. (Sowerby, Eng. Bot., 1110; Pharmacographia, p. 565; Bentley and Trimen, Med. Plants, p. 255). This Coniferous shrub or small tree is a native of Greece and widely distributed in Europe from the Mediterranean to the Arctic regions. It is also found in Asiatic Russia, in the higher regions of the Himalaya, and in North America. Over this vast area the common Juniper presents several varieties. In Europe it is generally met with as a bush of 2 to 6 feet in height, but in the interior of Norway it forms a forest tree of 30 to 40 feet, living a hundred years.† In the high mountainous regions of temperate Europe, and in arctic countries, it is a lowly shrub rising only about a foot above the surface of the soil.

The leaves are evergreen, subulate, rigid, sharp-pointed, spreading and opposite or in threes, usually glaucous above and dark green below. Flowers axillary, sessile, small, diœcious, the males discharging a copious cloud of yellow pollen: the females green, on scaly stalks. The fruit is commonly called a "berry," but is in reality that kind of cone called by botanists a *galbulus*, which has fleshy coalescent carpella, whose heads are much enlarged.‡ It requires two seasons to arrive at maturity; it is then about the size of a pea, of a blackish-purple colour, covered by a glaucous bloom. These fruit are marked superiorly with a triradiate groove,

* Pharm. Record, 1st August, 1888.

† Schübeler, Culturpflanzen Norwegens, Christiana, 1875, p. 143.

‡ Pereira, Mat. Med., ii., pt. i., p. 326, figs. 150, 151.

indicating the adhesion of the succulent carpella; inferiorly with the bracteal scales, which assume a stellate form. They contain three seeds. Their taste is sweetish, aromatic and terebinthinate, and their odour balsamic. They are very rich in sugar (which has been described as analogous to grape sugar), and by their fermentation and distillation an alcoholic beverage is obtainable, known in France as "Genièvre," and in England as "Geneva," or by abbreviation, "Gin."

The principal constituent of juniper berries is an essential oil; which can be separated by distillation. The yield from berries grown in various countries has been estimated by Messrs. Schimmel as follows:—

Bavarian..................	1·2	per cent
Italian	0·8 to 1	"
East Prussian............	0·6	"
Polish	0·9	"
Thuringian	0·7	"
Hungarian	0·8 to 1	"

the sp. gr. of these different products varying between 0·865 and 0·885 at 15° C. As regards quality, preference is generally given to the Italian oil, on account of its fine aroma and flavour.

Oil of Juniper consists principally of pinene, boiling at 155° C., and cadinene, boiling at 205° C. (the latter predominating in the ripe fruit). The peculiar odorous principle of the oil is a body boiling at 180°, and it is considered to be the acetic ether of a body allied to the terpenes present in the oil.

A specimen of crude oil of juniper, prepared by Flückiger, was found by him to deviate the polarised ray 3° 5′ to the left in a 50 m. m. tube.*

A volatile oil is also obtainable from the wood and the young parts of the tree, by distillation with water or steam.

The empyreumatic oil of juniper (*huile de Cade*) is obtained in France by dry distillation of the wood.

* F. & H. Hist., des Drogues, ii., p. 416.

PEUMUS BOLDU (after Bentley & Trimen).

Fig. 1—Branch of a male plant with flowers. 2—Upper surface of male flower. 3—Under surface of same. 4—Vertical section of same. 5—A stamen. 6—An anther, burst. 7—Carpels. 8—Vertical section of a carpel. 9—A fruit. 10—Vertical section of a drupe. 11—Embryo.

Fig. 1 reduced. Figs. 2, 8, 10 and 11 enlarged.

Boldo.

An odour very akin to that of the "Sweet Gale" (*Myrica Gale*, Lin.) is yielded by the leaves and young wood of the Chilian tree commonly known as "Boldo." This tree has at various times been described by Botanists under the following names: — *Peumus fragrans*, Persoz., Bot. Mag., t. 7024; *P. Boldu*, Feuillée, Obs. Pl. Peruv., iii., p. 11, t. 6; Bentley and Trimen, Med. Plant., t. 217; and Molini, Storia. Nat. Chili., pp. 185 and 350; *Boldea fragrans*, Jussieu, in Annales du Museum d'Hist. Nat., xiv., p. 134, and Tulasne, Monogr. des Monimiaceæ, p. 410, and in Arch. der Museum, viii., t. 31, f. 3; *Boldoa fragrans*, Lindley, in Bot. Reg., t. 57, and C. Gay, Flora Chilena, v., p. 353, also of D. Cand. Prod., vi., pt. 2, p. 673; *Peumus Boldus*, in Baillon Hist. Plant., i., fig. 324; *Ruizia fragrans*, Ruiz and Pavon, Floræ Peruvianæ Prodr., p. 135, t. 39, and Systema Floræ Peruviani, pp. 266-278; Endlicher Iconographia, t. 21, and Lindley, Veg. Kingd., p. 298, f. 205* It is a native of Chili, and has not been observed in any other country. In the central provinces it is very common, growing on sunny hill-sides in the neighbourhood of Valparaiso, Santiago, Conception, &c. Formerly it was met with only on the mountains but it now grows in cultivated districts. It is never met with in a forest, but always grows isolated. In a good soil its development is rapid. It is cultivated in gardens on account of its handsome appearance, evergreen, aromatic and medicinal leaves, and the very fragrant flowers, which appear especially in Autumn, but the bloom seems to be produced all the year round, although the buds take a long while to mature. In cultivation at Kew and the Regents Park the tree has flowered in winter.

This shrub attains a height of 10 to 20 feet, having cylindrical branches bearing many cylindrical, opposite branchlets, covered with a thin, pale grey-brown, nearly smooth bark, which is adherent to the wood, corrugated longitudinally, and having scattered lenticels. The young twigs are rough, with stellate hairs. The bark and the young twigs are very aromatic; the

* The tree is also referred to in Journ. de Pharm. and de Chim. [4], xv., p. 223, and xvi., p. 191; Pharm. Journ. [3], iii., p. 323, and v., pp. 405 and 453; Year-book of Pharm., 1873, p. 97; also under the title of "Etude sur le Boldo" in a "Thèse presentée et sóutenue à l'Ecole supérieure de Pharmacie de Paris par Claude Verne, 1874.

wood slightly so. The leaves are numerous, opposite, very slightly stalked, without stipules, evergreen, 1¼ to 2½ inches long, broadly oval, very obtuse at the apex, usually rounded at the base, margins quite entire, somewhat undulated, often re-curved, thick, dark green, bullate and shining on the upper surface, paler beneath, rough on both surfaces with scattered, wart-like projections, which on the under surface are set with short, spreading bristles; there are also numerous minute stellate hairs beneath. The mid rib is prominent: veins alternate, sometimes opposite, and covered on the surface with small glands.

The flowers are pale greenish-yellow, very agreeably odorous, unisexual (diœcious), on long stalks, ½ to ¾ inch wide, erect, arranged in short, lax, few-flowered, terminal or axillary, small trichotomous cymes, with minute, deciduous bractes. The centre of the male flower is occupied by about 30 stamens, inserted irregularly. In the female flower the stamens are usually represented by 5 small abortive staminodes. The fruit consists of 1 to 5 (usually 3) pale-yellowish green drupes, about the size of a pea; the rather scanty pulp is succulent, sweet and aromatic, adherent to the stone, which is thin, irregularly channelled, bony and very hard, with a perforation on one side at the top. They are made into necklaces by the Chilians. The seed is solitary, completely filling the stone. These fruits must not be confounded with those known in the markets of Chili as "*Peumo*," or "*Boldu*," produced from a genus of *Lauraceæ*.

Boldo leaves in the dried state have a reddish-brown colour, a coriaceous texture, and are covered with small glands.

The histological study of the plant by Claude Verne above referred to was made from portions taken from a tree growing in the Botanical Garden of the Ecole de Médecine, Paris. He states that a transverse section of the limb of the leaf showed the following characters:—

"The upper epiderm has one, two, or sometimes three rows of cells, especially in the neighbourhood of the insertion of some hairs which originate in the second row. These hairs are simple, rarely bifid, in form like birds' claws, conical, arched, and lie parallel to the surface of the leaves. The inferior epiderm, pierced all over with stomata, has but a single row of cells, and its stellate hairs, of the same form as the preceding, sometimes penetrate

beyond the epidermic tissue into the parenchyma. The parenchyma is divided into two zones, one having oval-oblong cells, gorged with chlorophyll, the principal axis of which is perpendicular to the surface of the upper epiderm; the other having polyhedric cells, less green than the others, containing in the interior thinly scattered grains of chlorophyll. Both zones are furrowed by the fibro-vascular tissue proceeding from the nerves of the limina, and in the second moderately large lacunæ frequently occur. The vessels containing the essential oil are found principally in the latter zone; rarely they occur in the former. The oil vessels differ in shape from the neighbouring cells, being perfectly spherical and of a greater diameter, and this form remains the same in whatever part they are found. There is no trace of chlorophyll in the interior, but sometimes the thick enveloping membrane retains small green granulations, and the rest of the cavity is filled with a refracting liquid. In places where this membrane has been cut by the razor its texture appears close, firm, and transparent, and the liquid may be seen protruding beyond the envelope. This liquid is white, and transparent in the green leaf; in the dried leaf it has a yellowish green tint, and does not fill all the cavity, being divided into little drops, imprisoned at the bottom of the organ. Cells containing essential oil are met with in nearly every part of the plant."

On making a chemical examination of the imported leaves, Verne states that "some leaves mixed with portions of the stem, coarsely powdered, were placed in a displacement apparatus, and treated successively with ether, alcohol, and distilled water. Treated with ether, they yielded 2 per cent. of essential oil, a trace of alkaloid and citric acid, and an aromatic substance (probably resin). To the alcohol they yielded a small quantity of essential oil, alkaloid (abundantly precipitated by double iodide of mercury and potassium), citric acid, sugar, and aromatic matter. To the distilled water they yielded sugar, gum, citric acid, and tannin. The abundant proportion of essential oil (2 per cent.) was obtained in repeated operations. On distillation, a certain quantity of oil having an odour resembling that of the plant, passes over at 185° C.; the thermometer then rises gradually to 230° C., and after remaining stationary a few moments, rises to 300° C. The products of distillation, collected at 230° C., and between 230° and 300° C., compared with the first product, have a greater density and a

stronger odour, but the odour is always that of the whole plant. The proportion of essential oil is small compared with the amount of thick black aromatic matter which is left at the bottom of the retort, and is probably due to oxidation of the oil.

It is worthy of note that not more than a trace of oil could be obtained by distilling fresh leaves and stems taken from a plant grown in Paris.

The products of this plant have been for many years neglected and it is only recently that attention has been directed to its very fragrant essential oil and to the fact that the leaves and young branches possess tonic properties, stimulate digestion, and form a valuable remedy in liver complaints. In the small family of *Monimiaceæ,* to which this plant belongs, there are two other plants which are said to possess analogous properties, viz., the *Atherosperma moschata,* Labil., and the *Nemururon Veillardi.*

Myrica Gale.

The Bog Myrtle, Sweet Gale, Sweet Willow, Royal Pimento or Bastard Myrtle, belongs to the Genus *Myrica,* Nat. Ord. *Myricaceæ.* The species *Myrica Gale* is the only European species. It is a native of Britain and found in boggy places, the edges of ponds and on moors. It also occurs in France, in Holland and the northern parts of Europe and America. It is a dwarf fragrant shrub from two to four feet high, with deciduous, linear lanceolate-obovate, toothed or entire exstipulate leaves from two to three inches long. The leaves are very odorous and yield a fine oil by distillation. The flowers are male and female, in separate catkins on the same individual, appearing before the leaves; the male catkins are clustered.

The abundance of small berries which are borne by this shrub, yield, by treatment with hot water, as afterwards described, a peculiar wax called *Myrtle wax.* This wax differs in many respects from bees' wax, assuming shades of a yellowish-green colour, and when fresh, emitting a fragrant balsamic odour. It has in some

degree the unctuosity of bees' wax, and somewhat of the brittleness of resin. Its sp. gr. is greater, as in the solid state it sinks in water, whereas bees' wax floats upon it, and is not so easily bleached. It has been estimated by Dana* that the composition of these berries is as follows:—

Wax	32
Reddish-brown resin, soluble in acetic acid	5
Black powder	15
Amylaceous matter	47
	99

Candles manufactured from the wax diffuse a delightful odour when burning.

The odour of the leaves of both the following plants is approaching that of the English Bog Myrtle (Myrica gale):—

Vitex Negundo, Linn., Wight, Icones, t. 519; Rheede, Hort. Mal., ii., t. 12.

Vitex trifolia, Lin., Bot. Mag., t. 2187; Rheede, Hort. Mal., ii., t. 11.

The *Vitex* is common throughout India and Ceylon, and its medicinal properties recognised.† The two shrubs, the properties of which appear to be identical, are described by Sanskrit writers under the names Nirgundi, Sindhuvára, Sephálika, etc. The vernacular names in Hindustanee are Sambhálu and Nisinda; this last also applies in Bengalee. Other synonyms are given in "Pharmacographia Indica," iii., p. 73.

V. Negundo is the Lagondium of Rumphius. In India its leaves are often placed between the leaves of books, to preserve them from insects.

V. trifolia (which differs but slightly from *V. Negundo*) is described as a shrub (Nat. Ord. *Verbenaceæ*) of variable habit. It is met with in patches. As a general character the branchlets and underside of the leaves are white, with a fine tomentum, the leaves petioled, 3 to 5 foliolate; leaflets lanceolate, long, acuminated, entire or coarsely cut and crenated; panicle terminal, pyramidal;

* Journ. de Pharm., lxxxix., p. 154.

† Bontius, Deseases of India, p. 226; Fleming, in As. Res., xi.; Ingledew, in Edin. Med. and Surg. Journ., 1817, p. 530; Pharm. of India, p. 163.

flowers blueish-white to blue; berry black, the size of a pea. When growing near the sea it has almost always 3-foliolate entire leaves, the leaflets being attenuated into the petioles; inland, the shrub has a more delicate appearance, the petioles of the leaves are much longer, and the leaflets, from 3 to 5 in number, are often serrated. The serrated variety is preferred for medicinal uses. The leaves of both varieties appear to be equally aromatic (the odour, as before mentioned, reminding of *Myrica Gale*. The berry is feebly aromatic. The leaves contain principally an essential oil and a resin. According to Dymock, the oil possesses the same odour as the leaves, is neutral and almost colourless. The resin dissolves in alkaline solutions, with a reddish-brown colour, softens below 40° C., and gives off aromatic vapours when heated.

Myrica cerifera.

The "Candleberry, Bayberry or Wax-myrtle" of North America is the *Myrica cerifera*, a branching shrub of 4 to 8 feet high,—sometimes higher,—with greyish bark, oblong or obovate-lanceolate, entire, or sinutely toothed, exstipulate leaves and scattered male catkins. This shrub abounds in Louisiana and New Brunswick and is widely disseminated in dry woods and open fields from Nova Scotia to Florida. It is also found in the Bahama Islands and is cultivated in Cape Colony.

The fruit is small (smaller than that of Black Pepper), dry and juiceless, consisting of a globular woody stone enclosing one kernel. The black granulations of the outer skin of the berry are covered with a pure white mealy crust of wax.

Of the North American species, *Myrica Carolinensis* and *M. Pensylvanica* are considered the most valuable.

The best method of collecting the wax is to scald the berries with boiling rain water, covering them to the depth of several inches, and after a few minutes pouring off the liquid into another vessel and skimming the wax at once from the surface. This is the exterior coating only of the wax, and is of a yellow colour. The marc is then to be boiled to extract the wax remaining in the pulp, which is skimmed off in the same way, this is of a green colour and much less balsamic in odour than the first portion.

Both waxes are strained of adherent water, re-melted separately, purified by straining through clothes, and cast into cakes.

It congeals into a concrete substance of agreeable odour and rather harder and more brittle than bees' wax. It is somewhat diaphanous, slighty heavier than bees' wax, of about the same weight as water when cold, but slightly lighter when melted. It is insoluble in water; scarcely soluble in cold alcohol; soluble with the exception of 13 per cent. in 20 parts of boiling alcohol, which deposits the greater part on cooling. It is soluble also in boiling ether and slightly so in oil of turpentine. The green colour, as well as the bitter taste, depends on distinct principles, which may be separated by boiling the wax with ether, and allowing the liquid to cool. The wax is deposited colourless, while the ether remains green.

Myrtle wax burns with a peculiar clear white flame, producing little smoke and during the combustion emits an agreeable aromatic odour. Its analysis proves it to be almost identical in composition with the wax of the berries of the Sweet Gale, the only difference being that it contains 0·5 per cent. more of resin.

The Myrtle wax from New Jersey is yellow, more granulated and unctuous to the feel, bearing a greater resemblance to bees' wax, and has much less astringency than that procured from New England. Possibly it is produced from a variety of *M. Gale* and not from *M. cerifera,* or it may be the wax obtained by simply scalding the berries, and not boiling them.

Of the genus *Myrica,* or "Wax berry," there are five species and two varieties which are indigenous in South Africa.* :—

1. *M. Æthiopica.*—Leaves elliptic, serrate towards the point, at the base entire; met with both on stiff and light soils, and most frequently in rocky situations.†
2. *M. Serrata.*—Leaves lanceolate, attenuated towards the point, sharply serrate, tomentose; catkin bisexual, scales egg-shaped, pointed. Generally on level ground, and common on all descriptions of soil.‡
3. *M. quercifolia.*—Leaves oblong, bluntly-waved margin; the

* Harvey, S. Afr. Gen., p. 309.

† Plunkenet's Phytographia, t. 48, f. 5.

‡ Figured in Burmanni variorum Africanum Plantarum, Decades 10.

young branches downy. It is found in sandy soils in the Cape district and S. E. Coast, and frequently with *M. serrata.** Of this species there are two varieties cultivated in English gardens.

4. *M. laciniata.*—Leaves oblong, linearly divided from the margin towards the mid-rib in a feather-like manner. The younger branches covered with resinous punctures. Found principally on sandy loam or clay soil in the George district.

5. *M. cardifolia.*—Leaves somewhat heart-shaped, serrate, sessile, somewhat imbricated. There are two varieties of this species; the leaf margins of one of them being entire.† *M. cardifolia* affects a more moist soil, although it has been found to grow well on the sands on some parts of the Cape Flats, but this is owing more to the age of the plants, having in the first instance vegetated in a better soil, the sand afterwards accumulating by degrees about their stems keeps the roots cool and comparatively moist, and enables the plant to resist the drying heat of the atmosphere, and extend both root and stem in all directions; the latter generally forming new roots in the upper layer of sand, which, descending, contribute to the support of the plant.

The soil most congenial to the growth of Myrica is that of a sandy nature, dark in colour from the vegetable matter that it contains, but such is the nature of these shrubs in South Africa that they appear to thrive in soils and situations of very opposite character, and to be equally productive on loamy sand as they would on the lighter and richer bog earth. In the latter, if very moist, and insufficiently drained, the plant would be injured by the stagnant moisture.

The *M. cardifolia*, producing the largest berry, is the species mostly recommended for culture in South Africa, as being the most profitable in crop, also by reason of the character of its growth, its spreading branches more rapidly covering the ground than any of the other species.

* Jacquin, Fragmenta Botanica, Fasc. 2, t. 1, f. 4.

† Plunk. Phy., t. 319, f. 7.

The following directions for rearing, planting, etc., were given by the Cape of Good Hope Agricultural Society :—In the months of April or May, prepare substantial boxes of 12 inches in width and the same in depth, inside measure, and of any convenient length, perforating the bottoms with small holes, covering them with gravel or small stones to the depth of 2 inches, then filling the boxes to within 1½ inch of the tops with black vegetable sandy soil, or with a mixture of decayed (two-years old) leaf mould and of sandy loam in equal parts. Sow the berries thickly on this, and cover them with half an inch of soil, pressing it smoothly down, and thus leaving a space of about one inch for the reception of rain, or the occasional watering required in dry weather. The boxes to be placed in a situation shaded from the sun, but not under the shade of trees as the plants would be drawn up weakly. The soil should be kept moderately moist and as equally so as possible; alternate extremes of drought and moisture check and injure the protruding radicle of the seed. The seeds will, if fresh, vegetate in about three weeks or a month, and as the young plants appear above ground they must be kept free of weeds and occasionally watered. When the plants are about twelve months old they ought to be large enough for planting out, and this should be effected during the months of May, June, or July, as the most likely season to ensure success. On planting out at this season, they may be placed in patches of three plants each, the patches to be not less than four feet, nor more than nine feet apart. If the ground to be planted should be very sandy, or entirely so, holes may be dug at the proper distances and filled in with at least a cubic foot of earth similar to that used in the boxes, tramping the same firmly down before the plants are inserted; and unless showery weather happens at the time of planting, it will be necessary to apply water by hand.

If boxes are not made use of, the ground to be occupied may be prepared in patches as above, and the seeds sown at once, placing about a dozen of the berries in each patch, keeping the plants free from weeds, and thinning and regulating at the proper season such plants as are to remain.

The *Myrica* may be also propagated by layering the one or two-year old branches and by cuttings of the young ripened wood. The first mode would strike root most readily, but be more trouble-some and less efficient than raising the plant from seed.

In South Africa, the wax is extracted from the berries by putting them in a pot of boiling water, stirring gently and skimming the surface with a ladle. The wax is strained whilst hot through coarse cloths and moulded into cakes. The wax separates from the berries and can be skimmed off within about five minutes of the time of putting the berries into the water. Not many berries are thrown in at a time so as to allow the wax to find its way easily to the surface.

"**Columbian wax**" is prepared in the same way from *Myrica microcarpa*, Benth. There are several other species of *Myrica* abundant in Jamaica and St. Domingo, which also yield wax. Specimens of some of these products are in the Kew Museum and the Museum of the Pharmaceutical Society.

The variety of this wax known as "**Ocuba wax**" is obtained from one of the *Myricas* in the province of Para, on the banks of the Amazon, Brazil.

According to Moore,* it is composed of one-fifth of Palmitine and four-fifths of free Palmitic acid and a small quantity of Lauric acid.

The melting point of Myrtle wax has been recorded as 43° C. by Guibourt†; as 47·5° C. by Lervy, and as 49° C. by Chevreuil. Guibourt states that its melting point can be raised by keeping it in prolonged contact with boiling water or by exposure to the air in thin layers for the purpose of bleaching it, but its melting point would still not be higher than 49° C. For the manufacture of perfumed candles, this wax can be hardened and its melting point raised by the addition of "Carnauba wax."

Carnauba Wax (also called "Ceara" and Brazil Wax) is a fragrant production of the *Copernicia cerifera*, Martius, the "Wax Palm of Brazil." This palm attains a height of 30 to 100 feet, and has a trunk 6 or 8 inches thick. The leaves arise from the summit of the trunk, they are of a bright green colour, fan-shaped, and terminate at the apex in sharp points. The solitary flowers along the spadex are very small, hermaphrodite, with a three-petalous corolla, externally of a green, internally of a

* Journ. de Pharm. et de Chim., xli., p. 456.

† Hist. des Drogues, ii., p. 281.

chestnut-brown colour. The first consists of an exterior slightly sweet pulp, which is considered a great delicacy, and is covered with a dark red or almost black skin. It encloses a round, hard seed, containing an oleaginous, almond-like kernel. The latter when pounded yields a sort of flour, forming an agreeable nutriment with milk, or a refreshing drink when mixed with water and sugar. The terminal leaf-bud, or so-called "palm cabbage" is quite small, but extremely savory and nutritious, as it contains an abundance of fecula resembling sago. The *wax* is secreted by scales, situated in the axillæ of the leaves, and is found on both surfaces of the scales, that on the upper surface readily detaching itself and falling on the ground when the tree is shaken. The method of collection is as follows:—The young leaf-buds and scales are cut off, dried for a few days, pounded, and the powder melted in earthern vessels with a little water. A more careful process appears to be practised in Aracati. The men split the buds with knives and hand them to the women, who carefully beat out the powdery substance with small sticks upon an outstretched cloth. It is then melted and run into cakes; the result constitutes the crude Carnauba wax. It is estimated that each tree yields about 4½ lbs. of wax, which is hard, brittle, and in the crude state of a dull, ashen colour. After purification it is of a greenish-yellow colour. Its odour is agreeable, somewhat resembling that of new hay and dried melilot.

On account of its high melting point, 84° C., it has been used in England for making candles. In the melted state it can easily be purified by filtration through cloth; by this process the wax assumes the yellowish-green colour natural to it when pure and its peculiar odour becomes more apparent. Statistics and information concerning this useful palm are given in a brochure entitled "Notice sur le palmier Carnauba," par De Macédo, Paris, chez H. Plon. Carnauba wax has been investigated by Maskelyne.* Its sp. gr. is 0·99907. It leaves about 0·14 per cent. of ash when burnt. By saponification with alcoholic potash it yields a considerable quantity of *myricyl alcohol*, $C_{31}H_{64}O$, melting at about 88° C., which exists in the wax in the free state, and may be dissolved out from it by alcohol. The wax also contains quantities of other alcohols very difficult to separate. By

* Journ. Chem. Soc. [2], vii., p. 87.

repeated crystallisation from benzene and ether it appears to yield an alcohol, $C_{23}H_{48}O$, melting at 78° C., and a substance, $C_{39}H_{82}O_3$, melting at 105° C.*

Carnauba Wax has an extensive consumption in the northern provinces of Brazil especially at Ceara, where it has become an important branch of industry. The annual export of this wax is, according to our Consul's report, about 871,000 Kilos.

Copernicia cerifera is one of the most useful trees in Brazil, developing itself without any culture in Ceara, Rio Grande do Norte, Bahia, &c. Perhaps in no country is a plant applied to so many and varied purposes. It resists the most prolonged drought and preserves itself constantly luxuriant and green. Its roots possess the same medicinal properties as the Salsaparilha. From the trunk are obtained strong fibres, which have a beautiful lustre, and timber very useful in the construction of palisades and enclosures. From the upper part of this palm, called the Palmetto top, a very nutritious food is prepared, also a wine, vinegar, and a saccharine matter. During times of excessive drought this tree has often served as a means of support to the populations of Ceara and Rio Grande do Norte. From the wood of the tree musical instruments are made, also tubes serving for the cylinders of pumps. The delicate fibrous substance of the pith makes a good substitute for cork. The pulp of the fruit is of agreeable taste, and the nut, oily and emulsive, is, after being roasted and reduced to powder, used as coffee by many persons in the interior. From the trunk of the tree a species of flour, similar to maizena, is extracted, as well as a liquid resembling that of the Bahia cocoa nut.

The Canauba wax which coats the leaves of *Corypha cerifera* Arrud., another Brazilian palm, is probably identical with the above product, inasmuch as it melts at 84° and yields by saponification an alcohol melting at 88° C.

A writer in the "American Druggist" has recently listed the chief varieties of vegetable wax, among which are included certain substances known as "vegetable tallows or fats," as follows :—

1. *Carnauba wax*, called also "Ceara" or "Brazil wax," from *Copernicia cerifera.*

* See also Berard, in Bulletin de la Société Chimique [2], ix., p. 41.

2. *Pela wax,* or "Chinese wax," from *Fraxinus chinensis.*

3. *Sumach wax,* or "Japan wax," from several species of Rhus.

4. *Kaga wax,* from *Cinnamomun pedunculatum.*

5. *Ibota wax,* from *Ligustrum ibotu.*

6. *Stellingia tallow,* or "Chinese vegetable tallow," from Stellingia *sabifera.*

7. *Myrica wax,* or "Myrtle wax," from *Myrica cerifera.*

8. *Orizaba wax.*

9. *Wax from stick-lac.*

10. *Bahia wax.*

(This list could be added to by enumerating various tallows from nuts of the *Sapotaceæ*).

Alcohol, ether, chloroform, petroleum spirit and alcoholic solutions of potash exert a solvent action on the various kinds of wax met with in commerce, and the behaviour of the solutions with solutions of ammonia, and with alcoholic solutions of lead acetate and of ferric chloride, has formed a means of distinguishing them from one another. The process is as follows:—A sample of the wax is heated with ten times as much chloroform to boiling, and, when completely dissolved, cooled in cold water.

1. The chloroform solution remains clear after cooling:

A. Ether effects complete solution.

(*a*). Alcoholic solution of ferric chloride gives, with the alcoholic solution of the wax, a precipitate insoluble on heating—*wax from Myrica quercifolia.*

(*b*). Ferric chloride colours alcohol solution black—*wax from undetermined species of Myrica.*

(*c*). Ferric chloride colours brownish, but gives no precipitate—*wax from Myrica cerifera; wax from Orizaba.*

B. Ether dissolves only a part. A sample is boiled with ten times the quantity of alcoholic potash solution till saponified, and the soap heated with 100 volumes of water.

(*a*). The soap is completely soluble —*Japanese wax.*

(*b*). The soap partially soluble —*African Bees wax.*

2. The chloroform solution becomes cloudy on cooling:

A. Alcoholic solution of acetate of lead gives, with the alcoholic solution of the wax, after a few minutes standing, a cloudiness —*wax from Stick-lac.*'

B. Alcoholic solution of acetate of lead gives no cloudiness.

(*a*). The ethereal solution of the wax becomes cloudy on the addition of an equal volume of alcohol —*Brazilian wax.*

(*b*). The ethereal solution remains clear —*Bahia wax.*

Reflection on the plants yielding from the ducts and glandular hairs on the surface of their leaves aromatic products suitable for blending with other materials for purposes of fumigation, leads to the consideration of the gum Ladanum.

Ladanum or Gum Cistus.

This gum, which at the present time is chiefly used by the Turks for fumigation, and to some extent as a perfume, is an excretion from the short glandular hairs with which the exceedingly viscid leaves of *Cistus Ladaniferus*, *Cistus Creticus*, and some other allied species, are covered. It is collected in the manner hereafter described. The plants of the genus Cistus,—nat. ord. *Cistineæ*,—numbering about forty species, are mostly handsome shrubs from Western and Southern Europe, and North Africa. Some of the species are hardy in the South of England, and are commonly known by the name "Rock Rose."

Various plants of the genus *Cistus* are found dispersed over the whole island of Cyprus, but occur in abundance only in the neighbourhood of Baphos, a small town surrounded by lofty mountains. The plants (which in this locality appear to have a more powerful and balsamic odour, and to exude more resin than those elsewhere) are called by the inhabitants of Cyprus Ξυσταρια, *Xystaria*, a word probably corrupted from the ancient name κίστος,

Cistus, or κίστη, a box or capsule, because of the remarkable shape of the capsules.* The leaves of these shrubs are opposite, entire or toothed, oblong or lanceolate. The flowers are large and showy, resembling a single rose, but very evanescent, and not opening in dull weather. Sepals 3 to 5. Petals white with a yellow or purple blotch, or rose with a yellow spot at the base, never wholly yellow, although that colour is very common among the *Helianthemums.* Capsule covered by the calyx, 5 or 10-valved with a seminiferous partition in the middle of each valve, therefore 5 or 10-celled. Seeds ovate, angular. The genus is technically distinguished from *Helianthemum* by the number of valves of the capsule, and by the flowers being cymose or solitary, seldom racemose.

The name of the nearly allied genus *Helianthemum* is constructed from the words *ηλιος* (the sun) and *ανθος* (a flower) because the flowers open with the rising of the sun in the morning, and the petals fall off with the setting of the sun in the evening. The flowers of both *Helianthemum* and *Cistus* only last for a few hours while the sun shines; but if the weather is dull and the sun does not make its appearance, the flowers do not open, and should they remain unexpanded for several days together they will decay in the bud. There are about 150 species of the genus *Helianthemum*.

C. ladaniferus (Lin., Spec. 737, Bot. Mag., t. 112. The writer in Curtis' Botanical Magazine justly observes that "this is one of the most ornamental hardy shrubs we possess; at once pleasing to the eye and grateful to the smell; the whole plant in warm weather exudes a sweet glutinous substance, which has a very strong balsamic scent, so as to perfume the air to a great distance." Its blossoms, which appear in June and July in great profusion, exhibit a remarkable instance of quickly-fading beauty, opening and expanding to the morning sun, and before night strewing the ground with their elegant remains; as each succeeding day produces new blossoms, this deciduous disposition of the petals, common to the genus, is the less to be regretted.

It is a native of Portugal, where it grows wild over leagues of country. It is also common in Spain. Its leaves are almost

* Tourn. inst., 259, t. 136; Gært. fruct., t. 76; D. C., Fl., fr. iv., p. 811; Prodr, i., p. 263. Upwards of thirty coloured figures of these plants are given in Sweet's "Cistineæ."

sessile, 3-nerved, lanceolate; upper surface glabrous and glutinous; under surface covered with a dense white tomentum. Its large white flowers have a purple blotch at the base of the petals. Its varieties are:—

Var. a, albiflorus (D. C., Prod. 1., p. 266; Sweet, Cist., t. 84). Petals white, yellow at the base.

Var. γ, maculatus (D. C., Prod. 1., p. 266; Sweet, Cist., t. 1., *C. ladaniferus β, planifolius*, Ait. Hort. Kew., iii., p. 305).

A much more common plant in gardens than *C. ladaniferus* is *C. Cyprius*, which is often confounded with the former, but has large and always solitary flowers and petiolate leaves, whilst the flowers of *C. ladaniferous* are born in clusters of three or four on a common stalk, and the leaves are sessile.

Cistus Ledon (Lam. Dic., ii., p. 17; Duh. Arb., i., p. 168, t. 66). Leaves connate, oblong, lanceolate, nerved; upper surface smooth, shining; under surface silky, villous; flowers corymbosely cymose; peduncles and calyx clothed with silky villi. Native of the South of France. Its petals are white with a yellow mark at the base of each. The height of this shrub is 1 foot.

Cistus Creticus, Lin. Spec., i., 738; Jacq., Icon. rar., i., t. 95; Sweet, Cist., t. 63; Woodville, Med. Bot., t. 91; Smith, Flor. Græc., 495; Buxbaum, Plantarum, iii., p. 34, t. 64, f. i.; Bentley and Trimen, Med. Plant., t. 24; Pharm. Journ. [i], x., p. 349.

This is the "Cretan Rock Rose," a native of rocky ground in Macedonia, Thrace, Greece, and the islands of Crete, Rhodes, Sicily, and Cyprus, in some of which it is very abundant. Boissier* considers it a variety of the variable *C. villosus*, Lin., which is spread over the Mediterranean district from Italy to Palestine, and occurs also in Corsica and North Africa.

It is a small bush with numerous spreading, opposite, terate branches, with a rough grey bark, the younger twigs densely covered with tufts of short white hairs. Leaves ½ to 1½ inches long, opposite, readily falling, sessile, obovate-spathulate, acute or obtuse, tapering into a broad attenuated almost sheathing base entire, bright green, glandular and tomentosely hairy on both sides, with prominent reticulate veins beneath, thick, wavy, and

* Flor. Orient., i., p. 347.

wrinkled. Flowers abundantly produced in small cymes at the extremities of the branches, 1½ inches wide, stalked. Sepals 5, leafy, very broadly ovate, suddenly narrowed to an acute apex, strongly veined, hairy like the leaves, also with long hairs on the back, margins membranous, imbricate in the bud. Petals 5, roundish, imbricate, much crumpled in the bud, delicate, of a clear purplish pink with a yellow base; soon falling. The fruit is a small capsule ⅜ inch long, ovate, acute, brown, furrowed, 5-valved. Seeds numerous, orange-yellow, roundish, flattened.

Var. β, *crispatus* (D. C. Prodr., i., 264). Leaves waved or curled. Flowers purple.

Var. γ, *Tauricus* (D. C., Prodr. i., 264). Leaves flat, very villous on the under surface, as well as sepals. Flowers purple. Native of Tauria.

The leaves of all varieties are exceedingly viscid. The glandular structure of the short hairs is figured in Unger and Kotschy's work on Cyprus "Die Insel Cypern," p. 403.* The *Cistus ladaniferus* and *C. Ledon* do not produce gum ladanum in such large quantities as *C. Cretus*. The collection of such an epidermal secretion from living plants is probably unique amongst the economic products of the vegetable kingdom.

In Cyprus, ladanum (sometimes spelt "Labdanum,") is collected by the shepherds by combing it from the fleeces of the sheep, which become loaded with it while they are pasturing. In Crete, however, a special instrument called a *Ladanisterion* is used, a kind of double rake with leathern thongs instead of teeth, and used in the manner of a whip. The straps become quite cylindrical, and rope-like when fully charged by the adhering resin, the bulk and weight of which is increased by the straps being rolled about in the sand. (As much as 72 per cent. of sand has been found in a sample.) The resin is ultimately scraped off the straps with a knife, and kneaded or moulded into cakes of different sizes and shapes. The work of collecting is rather unpleasant than laborious, because it must be done in the hottest season of the year, when the plants are most glutinous from being covered with this resinous exudation, and in the sultriest time of day when there is not a breath of wind stirring which might cause dust to be blown on to it, and yet the purest Ladanum is not free from dirt, because the

* In that work the plant is referred to on pp. 336 and 393-410.

winds of the preceding days have blown dust upon the shrubs which sticks to the clear shining drops which sweat through the texture like a fatty dew. A good worker will gather about three pounds two ounces per day.*

The description of the collection of Ladanum, given by Dioscorides† who lived in the first century, equally applies at the present day, *i.e.* (according to Tournefort's statement), the Ladanum was gathered not only with whips, but by carefully combing off such of it as was found sticking to the beards and thighs of the goats, which fed principally upon the leaves of the Cistus.

Pierre Belon, a French physician and traveller of the 16th century, in his "Observations de Phisievrs Singvlaritez et Choses Mémorables trouuées en Grèce, Asie, Judée, Egypte, Arabie, et autres pays estranges," Paris, 1555, faithfully narrates the mode of collecting the drug in the Island of Crete, in which account he is entirely confirmed by Tournefort, who was an eye-witness of the operation in July, 1700.

The descriptions given by Belon, Tournefort, and Landerer, confirm in an interesting manner the accuracy of older writers, and strikingly exemplify the persistent character of Eastern customs.

The authorities of Kew considered it worth while to endeavour to obtain for the Kew Museum a specimen of the singular instrument called "Ladanisterion," and, with the help of the Foreign Office and H.M. Consul in Crete, an excellent example was obtained and placed in the Museum. A drawing of that instrument, with some descriptive notes, was contributed by Mr. Thiselton Dyer to the Pharmaceutical Journal of 18th Oct., 1884.‡ The extreme width of the specimen is 25 inches; the length of the handle is 45 inches, and that of the straps from 36 to 39 inches. The illustration on opposite page represents its appearance.

In Tournefort's figure the arms which carry the straps are less curved than in the modern example, and the straps are longer.

These instruments are also known under the name "*Ergatiri.*"

The best Ladanum is in dark masses of the consistence of soft

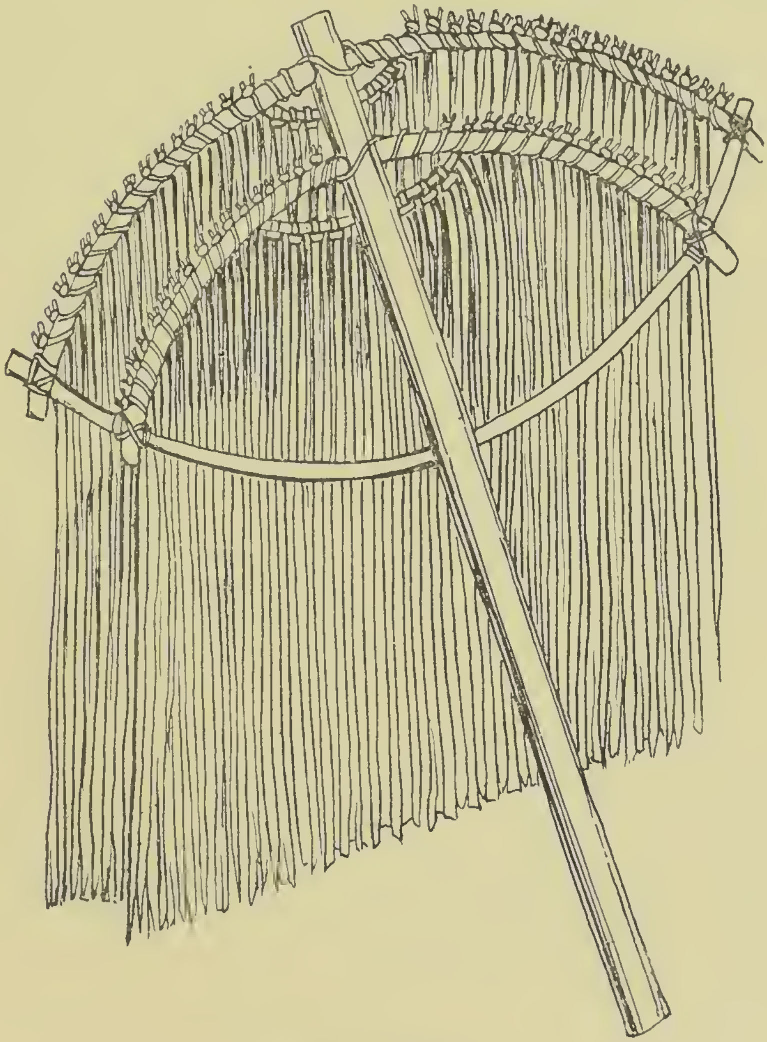
* Tournefort's "Voyage to the Levant," i., pp. 56-60; London, 1718.

† Pedacii Dioscoridis Anazarbei de Medicinali Materiâ, fol. 1516, lib. i, cap. 130.

‡ Pharm. Journ. [3] xv., p. 301.

plaster. An inferior sort is in long rolls, coiled up, much harder than the preceding, and not so dark.

The late Dr. Landerer of Athens, stated, in a communication to the Pharmaceutical Society (translated by Daniel Hanbury), that "Cyperian Ladanum," which is truly *Ladanum e barbâ* is met with in two states, namely in sticks (*Ladanum Cyprium in bacculis*) and in irregular masses (*Ladanum Cyprium in massis*).



LADANISTERION.

In Crete, the best laudanum is considered to be that which is moulded or contorted into spiral forms (*Ladanum in tortis*), but Cyprian ladanum is preferred at Constantinople to the best from Crete. This seems very strange, as the substance collected with the leathern thongs must be purer in odour than that collected

from the fleeces of sheep and goats, which must be to some extent contaminated with the offensive rank smell of those animals; the Ladanisterion may also be employed in Cyprus, but the term "*Ladanum e barbâ*" implies that it is combed from the fleeces. The gum is known to the Greeks as "*Ladano*," and to the Turks as "*Laden*"; its correct Persian designation is "*Rabentèh.*"

The gum (Ladanum), is collected entirely in what is known as the "Pyliria" district, which is the hilly country stretching from Yallia to Levka on the north-west of the island of Cyprus.

The Ladanum when fresh, is packed in little wooden cases, leaves of the Bay tree, or more commonly of the *Ceratonia siliqua* being laid between the pieces in order to prevent their adhesion. The residue after the fusion and purification of the Ladanum is employed by the Cypriots in the preparation of certain balsams and plasters called *Ladano-balscham*, and of an oil called *Ladanoladon*, *i.e.*, ladaniferous oil, for which purpose it is combined with terpentine and oil of sessamé."

Dr. Landerer also observes, respecting the Cyprian Ladanum when collected by sheep or goats, that "in addition to the Cistus, various other glutinous plants equally agreeable to the animals occur, and chiefly in moist and well-watered situations. These plants to which the names κώνυζα, βρώμιτζα and ψύλλιστρα are applied, are *Erigeron viscosum*, *Erigeron graveolens*, *Inula Critannica*, and *Inula odora*; these (according to Dr. Landerer) being still more gummy than the Cistus itself, contribute even a larger amount of resinous matter to the animals than that plant. (The names ψύλλιστρα and κωνυζα are derived from ψύλλος (a flea), and κώνοψ (a mosquito), on account of an attraction possessed by the plants for these insects, of which property, and their glutinous nature, advantage is sometimes taken by suspending small branches of them over beds in order to attract and detain these troublesome creatures.)

"In order to compensate for the loss of fragrance which the admixture of the resin of the Erigeron and other plants would occasion, various odoriferous substances are frequently added. Of these the chief is mastich, that being one of the most esteemed and usual of oriental perfumes." This may account for the terebinthinate odour observable in some samples, and renders it evident that the purest ladanum is that collected in Crete, as the

Ladanisterium would not be applied to other plants, and would not contain the hairs of sheep or goats *which would give off ammoniacal odours when the drug is burned as incense.*

The quantity annually produced depends much on the state of the weather. It is said that about 6000 lbs. of the drug are annually exported from Crete, and about 2500 lbs. to 2800 lbs. from Cyprus. Some Ladanum is also collected in Spain and Portugal, but not exported. The price is very variable, being affected by the colour, odour, and consistence of the drug; that of a deep brown, and such as melts most readily, is preferred. The oriental mode of applying this test to examine the quality, is to place a fragment of the drug on the edge of a "Mangal" (a copper stove, which when filled with lighted charcoal is placed in the middle of an apartment) and if the ladanum very rapidly melts into a transparent liquid, it may be regarded as of the best quality.

The purest ladanum has a dark-reddish or almost black colour externally, and internally it is greyish. It readily softens by the heat of the hand. Its odour is very agreeable and balsamic; its odour has also been compared to that of ambergris. Its taste is balsamic, bitterish and slightly acrid. It is very inflammable, and burns with a clear flame. A sample of Cyprian ladanum "*in bacculis*," accompanying Dr. Landerer's paper to the Pharmaceutical Society, examined by Daniel Hanbury, yielded on combustion 37·7 per cent. of ash; while two other samples from a different source, left respectively 60·4 and 86·0 per cent. of incombustible matter. It is commonly very largely contaminated with sand and other earthy matters, sometimes to the extent of above 70 per cent. Guibourt found in *pure* ladanum 86 per cent. of resin, 7 per cent. of wax, a little volatile oil, and small quantities of unimportant constituents.

Pure Ladanum is almost entirely soluble in rectified spirit, forming a gold-coloured solution. An essential oil has been obtained by distilling the leaves; its sp. gr. is 0·925 at 15° C. It boils between 165° and 280° under partial decomposition, with a strong odour of acetic acid. The odour of the oil is unpleasantly narcotic and stupifying, differing from the odour given off when a piece of the gum is dropped into ignited charcoal.

A large quantity of very old Ladanum, of greyish-brown colour, has recently been distilled by Messrs. Schimmel and Co.,—the

result being that it yielded 0·91 per cent. of a golden coloured oil, "of a delicate, penetrating odour of ambergris, and of sp. gr. 1·011 at 15° C.* Of course it is impossible to know from which of the many species of Cistus this parcel was derived, and it is highly probable that the fragrance of the different species varies.

One of the most beautiful of the rosy-flowered species is **C. vaginatus**, a native of Teneriffe. Its hairy leaves are lance-shaped, three-nerved, and dilated towards the base, while the splendid large rose-coloured flowers are very numerous and in terminal panicles. The petals are crumpled and have wavy margins, bent inwards, with a yellow spot at the base.

C. populifolius is a very distinct species of large stature, with ovate-cordate, acuminate, rugose leaves on long petioles; it bears lateral cymes of medium-sized white flowers tinged with yellow at the base of the petals; the sepals are acuminate and clammy. The pubescence on this plant is slighter than in many of the other species, but viscous.

One of the hardiest species in cultivation is **C. laurifolius**; its leaves are petiolate, 3-nerved, ovate-lanceolate, viscous, and densely tomentose beneath. The flowers are white. This forms a robust shrub 6 or 7 feet in height.

A large number of species are in cultivation, and they would be more extensively cultivated if they were better known. Many of the species will survive through the winter in England in the open air, if the weather be not very severe. They will succeed in any common soil, or a mixture of loam and peat will suit them very well. They may be increased by layers; or young ripened cuttings, taken off at a joint, in July or August, and thinly planted under a hand-glass, will root readily. They may also be raised from seeds, which are produced in abundance; in this way, fair sized specimens may be obtained in three years. Most species thrive best in a dry soil.

Acorus Calamus, the "Sweet Flag."

The name *Acorus* is given to a genus of semi-aquatic herbaceous perennials belonging to the Natural Order *Aroideæ*, comprising a

* Bericht, April, 1893.

number of forms, which may, with advantage, be reduced to two species. The most interesting is the *Acorous Calamus* or "Sweet Flag," Lin., a plant apparently known to the Greeks as *ἄκορον*. Under the same name "akaron" it was known to the Arabs, and has been from a very early date a drug of great fame in India under the Sanskrit name of "*Vaka*" and the Hindi name "*Bach*," but it is not to be confounded with the *Calamus Aromaticus*, Royle, which is the Indian grass *Andropogon Shœnanthus* Lin. (vide p. 44, 1st Series), and probably the *κάλαμος ἀρωματικὸς* of Dioscorides, and *κάλαμος* of Theophrastus.

The *A. Calamus* grows in ponds, by the banks of rivers and other wet places in England, being very plentiful in the rivers of Norfolk. It is also found in the cool parts of Europe, of India and of North America. It has been stated to be a native of Europe, but is probably a native of Asia and was introduced into Europe. The London market used to be principally supplied from the rivers in Europe. According to Professor Johnston, as much as £40 has sometimes been obtained for the year's crop of a single acre of riverside land on which it naturally grows. It is now cultivated in damp, marshy places in India and Burmah and is exceedingly common in Mánipur and the Naga Hills, often appearing as a weed, spreading apparently from beneath the walls dividing the fields. In warm climates it developes greater fragrance than in England. From the lower part of the thick jointed stem or rhizome, which is very long, indefinite, branched and creeping in the mud, the plant sends down numerous long, straight, slender roots, while from the upper surface it pushes upwards a number of lance-shaped leaves from two to three feet in length, bright green, nearly an inch broad, sheathing at the base, also a long, leaf-like stalk, from one edge of which, a foot or more above the root-stalk, issues a tall, compressed, spathaceous scape and a lateral spadix, densely crowded with a mass of very small, greenish, bisexual flowers (odorous when bruised), each provided with a perianth of six pieces, enclosing six stamens and a three-celled ovary with a sessile stigma. For figure of this plant see Bentley & Trimen, Med. Plant, t. 279; Woodville, Med. Bot., t., 173; Sowerby, Eng. Bot., t. 356. Though naturally an aquatic plant, the Sweet Flag will grow well in gardens, but under such conditions rarely flowers. The leaves are much like those of *Iris*, but may be distinguished from that and such like plants by the

peculiar crimped edges of the leaves, and their aromatic odour when bruised or broken across. All parts of the plant, but especially the rhizome, have a strong, aromatic and slightly acid taste.

The English and German dried root, as it appears in the shops, under the name of *radix acori veri* or *radix calami aromatici*, is in flattened pieces of four or five or more inches long, and about as broad as the thumb; jointed, somewhat curved, of a spongy or corky texture internally; of yellowish-brown or fawn-colour externally, more or less shrunken and wrinkled, and buff colour or of slightly roseate hue internally. The fracture is short, the upper surfaces of the pieces marked transversely with the scars and fibrous vestiges of the leaves which were attached to them; the lower surfaces have numerous little elevated pale-coloured circular dots with a dark centre; these latter indicating the points from whence the roots proceeded. The rhizome deteriorates by keeping. In Germany the rhizome is usually peeled before drying it; it then appears as greyish white, spongy pieces, and is easily pulverisable, but the system of peeling it is unnecessary and very wasteful, as the receptacles containing the volatile oil are more abundant in the external portions of the rhizome. Such decorticated rhizomes are therefore less powerful in odour and of less value to the consumer than the ordinary unpeeled ones.

The pulverised root has been in use in England as a toilet powder, on account of the fragrance of its essential oil combined with its farinaceous substance. For this reason it also enters into the composition of sachet powders.

The rhizome is used in India in the preparation of an aromatic vinegar. The Bengalee name of the root is *Bàch*, and in Hindee it is called *Bàch ghor* or *gor Bàch*. In Tamil it is *Vashamba* and in Arabic, *Vaj*. On the Malabar coast it is known as *Vacha*, and under that name it was described and figured by Van Rheede as an Indian plant in 1692 in his "Hortus Malabaricus," xi., t. 48, 99. It has a stronger and more agreeable odour than that grown in Europe or the United States.

Dr. Dymock, in his "Notes on Indian drugs" thus describes the Indian root as it appears on the Bombay Market:—"The root stock occurs in somewhat tortuous, sub-cylindrical or flattened pieces, a few inches long and from ½ to 1 inch in greatest diameter.

Each piece is obscurely marked on the upper surface with the scars, often hairy, of leaves, and on the under with a zigzag line of little, elevated, dot-like rings, the scars of roots. The root-stock is usually rough and shrunken, varying in colour from dark brown to orange-brown, breaking easily with a short, corky fracture, and exhibiting a pale brown spongy interior. The odour is aromatic and agreeable, the taste bitterish and pungent." As regards its microscopic structure, Dr. Dymock says :—" A section of the rhizome is like an open net-work, composed of rows of nearly round cells and open spaces (water passages). Most of the cells contain small starch granules, but some of them essential oil. At the junction of the cortical and central portions of the rhizome is a very distinct row of small empty cells. The vascular bundles are numerous, especially just within the line of small cells just noticed ; each bundle consists of a ring of spiral vessels surrounding a number of jointed tubes. In the Bombay market, two kinds of "Vekhand" (the local name of the root) are known, viz. :— "Multani," value about 3½ Rs. per maund of 41 pounds, and "Ghati," value about 2½ Rs."

A volatile oil is distilled both from the leaves and from the root, that of the former being preferable for toilet perfumes and aromatic vinegars ; it is also used for scenting snuffs. The oil from the root has a burning, aromatic and camphoraceous flavour ; it is used in England to improve the flavour of gin and to impart a peculiar taste to certain varieties of beer. The flavour and aroma of both oils vary, however, according to the country in which the plant is grown, and the yield of the oil from the root depends on whether the root has been peeled or not.

Kurbatow* obtained, by fractional distillation of the oil of *Acorus Calamus* root, portions boiling between 140° and 280° C., a considerable portion invariably boiling between 158° and 159°. This portion was composed of the hydrocarbon $C_{10}H_{16}$, and possessed a terebinthinate odour ; it was soluble in alcohol and in ether, and was of sp. gr. 0·8793 at 0° C. At 250° he observed a blue oil distil over, and the hydrocarbon passing between 255° and 258° was but slightly soluble in alcohol, and would not combine with dry hydrochloric acid as did the portion boiling between 158°-159°, forming a crystallisable chlorhydrate fusible at 65°.

* Pharm. Centralhalle, 1874, p. 123.

According to "Pharmacographia," the dried root yields 1·3 per cent. of a neutral, yellowish esential oil of agreeable odour, deviating the polarised ray 13° 8′ to the right in a 50 m. m. tube.

Osse estimated the percentage of volatile oil in the dried root at the high figure of 3·90.* His method of determining the amount of volatile oils in plants is as follows:—Five grams of the finely powdered substance are shaken with 25 c. c. of petroleum ether (boiling-point not exceeding 40° C.) for several hours; the undissolved matter is then allowed to subside ; 1 c. c. of the clear liquid is drawn off, evaporated on a watch-glass in a current of dry air until the odour of the ether is no longer perceptible. The glass with contents is then weighed, the volatile oil driven off by heat and again weighed, the difference of the two weighings indicating the quantity of volatile oil. When the volatile oil is associated with a large quantity of fixed oil, a correction must be made for a very slight increase in weight, resulting from the heating of the fixed oil in air. For non-drying oils, 0·09 per cent. of the weight of the fixed oil is added to the weight of the volatile oil found." The amount of fixed oil, or resin found by Osse, working by this method, was 0·75 per cent.

Messrs. Schimmel have obtained by distillation of the *dried* German root 1·5 to 3·5 per cent. of volatile oil ; sp. gr. 0·960 to 0·980 at 15° C. ; optical rotation + 15° to + 21° in 100 m. m tube. From the *fresh* German root they obtained 0·8 per cent. ; sp. gr. 0·960 to 0·970; optical rotation + 21° to + 31°.† The same observers report on a parcel of calamus root received from Japan, that these roots do not differ externally from European calamus roots and are no doubt derived from the same species; they contain *five per cent.* of a highly aromatic essential oil having a sp. gr. of 0·985 to 1·00 at 15° C., which is considerably heavier than the German calamus oil. This oil boils between 210° and 290° C. ; if the distillate be collected in two fractions, the lower portion has the characteristic calamus odour, while the higher boiling portion gives off the peculiar sesquiterpene odour. Japanese calamus oil also differs from the European in solubility, one part dissolving in 500 parts of 50 per cent. spirit, the German oil requiring 1,000 parts of the same.‡

* Zeitschr. Oest. Ap. Ver., 1875, p. 441.

† Bericht, October, 1893.

‡ Ibid, April, 1889.

The bitter principle *Acorin* was first extracted from Acorus Calamus root by Faust, in 1867, who obtained it in the form of a semi-fluid brown glucoside, containing nitrogen; but he failed to obtain it in a crystalline form or even as a solid. In attempting to prepare this substance by the tannic acid method, Flückiger and Hanbury obtained* only a minute quantity of a very bitter substance, which however, was perfectly crystalline. The investigation was renewed by Thoms,† who, taking advantage of the property possessed by charcoal of absorbing bitter substances, attained more definite results. A quantity of perfectly dry rhizome, cut small, was macerated for two days, with five times its weight of distilled water, the liquor was then strained off and the residue pressed, after which the marc was stirred with a fresh quantity of distilled water, and again pressed. The united filtered liquor was allowed to digest for two days with freshly washed and ignited animal charcoal, with frequent shaking, at the end of which time it was entirely deprived of bitterness. The charcoal was washed on a filter with water as long as the filtrate showed any turbidity, then after being dried on a water-bath, it was boiled with 90 per cent. alcohol; this alcoholic extract was filtered, the alcohol distilled off and the turbid residual liquor shaken with ether. Upon evaporation of the ether, and drying over sulphuric acid, the bitter principle was obtained as a thick, clear, honey-yellow balsam, neutral in reaction, and with a faintly aromatic odour and very bitter aromatic taste. It was found to be insoluble in water, dilute acids and alkalies, but perfectly and easily soluble in absolute alcohol, methylic alcohol, ether, benzol, toluol, chloroform, carbon disulphide, and acetone. The yield of this body—which has been named *acorin*, and is represented by the formula $C_{36}H_{60}O_6$—was only 0·1854 per cent. When treated with dilute acids and alkalies in a current of hydrogen, acorin splits up into essential oil of calamus and a sugar; but when the reaction takes place in atmospheric air, the oil readily oxidizes and is converted into a neutral resin, *acoretin*, identical with resin, occurring in the rhizome. This resin, when reduced from alkaline solution by nascent hydrogen, gives the essential oil and sugar as final products. From the extract remaining after shaking out the

* Pharmacographia, 2nd Ed., p. 678, and Hist. des Drogues, ii., p. 499.

† Archiv. der Pharm., 1886, p. 465.

acorin with ether, was separated a small quantity of a strongly basic crystalline alkaloid, soluble in alcohol, chloroform and acetone, and insoluble in water and ether. It has been named "*calamine*."

The rhizome of *Iris Pseudo-acorus* (Yellow-Water Iris) sometimes occurs as an adulterant to Acorus Calamus, but it may be easily recognised by its darker colour, different structure, astringent taste, and absence of aroma. The rhizome should be gathered in early spring or late in the autumn, and dried quickly. On the banks of the Thames it is usually gathered early in May for the London market.

The odour of *Acorus calamus* is developed in the bark of *Croton Malambo*, Krst., a Columbian plant belonging to the Natural Order *Euphorbiaceæ*.*

Souchet.

The French name "Souchet" is applied to the dried tuberous roots of several species of *Cyperus*, which, on account of their aromatic properties, are used as perfumes. The genus *Cyperaceæ* (Sedges), contains an immense number of species, widely distributed over the warmer parts of the earth, and gradually disappearing as the extremes of north and south are reached. Many of these sedges are found in damp marshy places. Some are valuable for covering the sand and loose soil on the borders of rivers and streams, protecting the banks from being washed away by the current.† Some species are useful for textile purposes, for making ropes, mats, and for covering the floors of houses, and some are used in medicine. Their cellular tissue is sometimes used for paper and the tubers and underground stems of several species are used for food. Amongst the odorous species are :—

* Pharm. Journ., [1], iii., p. 169 ; Ibid, [2], i., p. 321, and vi., p. 255. See also Bentley's Man. Bot., p. 635.

† Lindley, Veg. King., 118.

C. rotundus, Lin., Sp. Pl., p. 67.*

The plant is synonymous with *C. hexastachyos*, Rottb. Descr. and Ic., t. 14, f. 2.

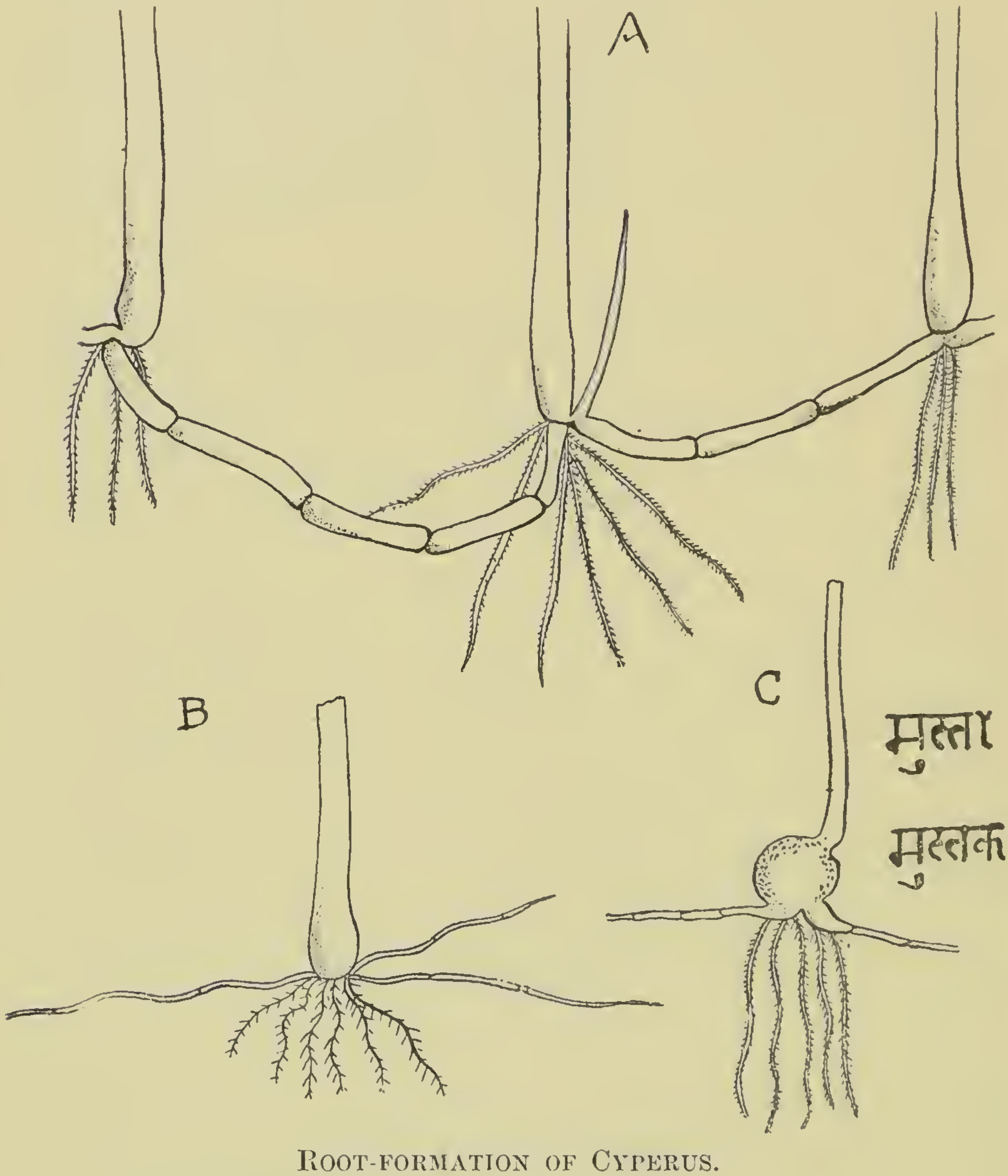
Its Indian vernacular names are very numerous. In the Hindee and Bengalee dialects, the tubes are known as *Mutha*; in Bombay as *Musta* and *Barikmoth*; in Singalee as *Kalandurn*; in Sanskrit as *Musta, Gundra, Bhadra muste,* also *Mustaka*; but for the whole list the reader is referred to the works mentioned at foot, especially Roxburgh's Flor. Ind. and Watt's Dict. of the Economic Products of India, ii., p. 686.

C. Rotundus is the *κύπερος* of the Greeks, and is mentioned by Dioscorides, who says it is the *Juncus* or *Radix Junci* of the Romans. Herodotus (iv., p. 71) notices it as an aromatic plant used by the Scythians for embalming. *Κύπειρον* is mentioned in the Iliad (21, l. 351) and Odyssey (4, l. 603), and by Theophrastus in his fourth book. Pliny (21, l. 18) calls it *Juncus triangularis* or *angulosis*.

The culms are erect, from one to two feet high, naked, three-sided, smooth, with the angles rounded. The leaves are radical, or only investing the base of the culm, sheathing, shorter than the culm, smooth and glossy. The umbels are terminal, compound in very luxuriant plants, sometimes decompound, from two to three inches each way, Umbellets from two to eight, all having peduncles of from one-fourth of an inch to two inches long. Involucre generally three-leaved, unequal, smooth; the largest is only a little longer than the umbel. Spikes linear, sub-sessile. Seed, three-sided, brown, rather rugose.

* The descriptive notices of this plant are to be found in the following works:—Journ. Lin. Soc., xxi., p. 167; R. Brown, Prod., p. 216; Roxb., Fl. Ind., i., p. 201; Nees, Pl. Medic. Abbild., t. 25, fig. A; Presl, Rel. Hænk., i., p. 175; D.C. and Lam. Fl. Franç., iii., p. 146; Kunth, Enum., ii., p. 58; Webb and Berth, Iles. Canar. Phyt., iii., p. 363; Hassk., Pl. Jav. Rar., p. 80; Benth., Flor. Hongk., p. 387, Fl. Austral., vi., p. 279; Griseb., Fl. Brit. West Ind., p. 564; Boeck., in Linnæa, xxxvi., p. 283; Baker, Fl. Maurit., p. 410; Cosson, Expl. Algér. Glum., p. 247; Boiss., Fl. Orient., v., p. 377; Clarke, in Journ. Lin. Soc., xxi., 167; Home Dept. Official corresp., regarding Pharm. Ind., 238; Hove's tour in Bombay, pp. 112, 120; Elliot, Flora Andhrica, pp. 25, 76, 120, 184; Modeen Sheriff, Supp. Pharm. Ind., p. 128; Dutt, Mat. Med. Ind., p. 264; Dymock, Mat. Med. W. Ind., 2nd ed., p. 844; Arjun, Bomb. Drugs, p. 150; Baden-Powell, Punjab Prod., p. 382; Birdwood, Bomb. Prod., 94; Jnl. As. Soc., Pt. ii., p. 82; Rumph., Amb., vi., p. 1, t. 1, figs. 1, 2.

This is by far the most common of the Indian species; it delights in a moist sandy soil, though it grows abundantly in most soils, being such a troublesome weed in gardens that there is no extirpating it, every little bit of the root growing readily. It occurs



Root-formation of Cyperus.

A—*C. scariosus*, R. Browne.
B—*C. esculentus*, Linn.
C—*C. rotundus*, Linn. ("Musta" or "Mustaka," Sanskrit).
(After C. B. Clarke.)

plentifully in the Kuram Valley, Afghanistan, Gilfit, and from Kashmir to Simla, Garhwal, and the Khasia Hills, throughout the plains (Lahore, Bengal, Madras) and ascending the mountains of the central table-land, from Mount Abu and Poona to the Nilghiri

Hills. The dried and powdered roots are used as a perfume by Indian ladies for their hair and clothes. An essential oil is extracted from the roots and used for the same purposes. The root is known in Jamaica under the name of "Adrew."

The ovoid or nearly round tubers are developed upon a thin underground stem; externally they are of a dark brownish rust colour (or nearly black when dried, according to Dymock), and give off numerous fine rootlets; inwardly they are firm, tender, white, and very fragrant. The aroma being somewhat similar to that of *Acorus calamus.*

Dr. Dymock found,* on microscopical examination of the tuber, that "the outermost layer of the cortical portion is composed of large bundles of reddish brown stony cells separated from one another by interspaces; within it are from 6 to 8 rows of very thick-walled empty cells; next a tissue of thick cells, most of them full of large starch granules, but some containing essential oil, and probably resinous matter. The central portion of the root is separated from the cortical by a single row of small yellow stone cells; it is composed of thick-walled cells, full of starch like those in the cortical portion, but differs from it inasmuch as many of the cells contain red colouring matter. Large vascular bundles abound in the root; some of them are surrounded by a layer of stony cells." In making this analysis, Dr. Dymock does not state whether the tubers he examined were those of *C. rotundus*, Lin., or of *C. pertenuis* Roxb., Syn. *C. Scariosus*, Brown, for (although he quotes the vernacular names, which are dissimilar) he states his belief that "these two plants are considered by botanists to be only varieties of the same species."

Cyperus scariosus. R. Brown, Prodr, p. 216., Syn. *C. pertenuis*, Roxb., Fl. Ind., Serampore Ed., p. 202.† The vernacular name in Hindee, Bombay, and Bengalee is *Nagur-Mutha;* in Arabic, *Soade-Kufi;* in Tamil, *Koriak-Kishangu;* in Telinga, *Tunga-gaddala-veru, Kolatunga-muste;* in Sanskrit, *Nagar Moostaka.* The roots of this species are somewhat tuberous, with

* Pharm. Journ. [3], xi, p. 169.

* Nees in Wight Contrib., p. 83; Kunth Enum., ii., p. 99. Med. Top. Ajmir, 147; Dymock, Mat. Med. W. Ind., 2nd Ed., p. 815. Irvine, Mat. Med. Patna., p. 75; Birdwood Bomb. Prod., p. 94; Hull Dic. Econom. prod. Ind., 687; Journ. Linn. Soc., xxi., p. 159.

many dark-coloured villous fibres, which when bruised emit a fragrant odour. The culms are three to four feet high, sub-rotund at the base, three-cornered above, straight and naked at the base. Its naked delicate form, small and compound umbel, slender leaves and scanty involucre, immediately distinguish it from all the other Indian species. It is met with in damp places in Bengal, Oudh, and occasionally in the Punjab, but it is by no means so common as *C. rotundus*.

Besides being used as a perfume for the hair, the rhizomes are used in dyeing and impart a scent to the fabric. Arabian and Persian writers mention this Indian Cyperus, but consider it to be inferior to *C. rotundus*. There are two kinds of "Nagur-Mootha" met with in the Bombay market, "Surat" and "Kathiawar," the first is heavier and more aromatic than the second. The value of the Surat is 2 rupees per maund of 37½ lbs, and that of the Kathiawar 1¼ rupees. The Surat "Nagur-Mootha" is probably obtained from Rajputana, where the plant is common in low wet places.

Two species only of Cyperus are natives of Britain, both of which are restricted to certain districts, and not found out of England. The *C. longus*, which Gerarde calls the "English Galingale," is said by him to possess "a most sweet and pleasant smell when it is broken." On account of its perfume, which some consider analogous to that of the violet, it is still used in compound perfumes, and is occasionally added to lavender-water. It is curious that the *Scirpus maritimus* is figured by Gerarde as the round "salt-marsh Cyperus," it having also tuberous roots. He notes that it grows plentifully in Shipey and Tenet, as Sheppey and Thanet were then called. In the portion of the herbaceous ground at the Royal Gardens, Kew, devoted to medicinal plants, the elegant sprays of *cyperus longus* are very ornamental in the flowering season of the plant,—about the middle of August. The odour of the dried root is considered somewhat analogous to that of *violet* or *orris*, and yet it is different from either of them. The odour of orris *approaches* to that of violet, but it is not so pure a type, not so simple, and is in fact a *compound* odour. It is possible that but very few plants yield *simple* odours. It has recently been pointed out by Jacques Passy in a memoir read at a meeting of the French Academy of Sciences,* that experiments prove that even pure

* Comptes Rendus, 31st October, 1892, cxv., p. 669.

substances of definite composition do not necessarily possess simple odours. Several different odours may co-exist in the same compound, and give to the sense of smell the impression of a simple odour when it is really a mixture. He states that such odours may be dissociated in such a way as they can be recognised or perceived individually. His description of the method of analysis may be abstracted as follows:—"If several odours exist in the same body, each of them should possess its individual or particular perceptible minimum or lowest quantity by which its presence is perceptible, which will not necessarily coincide with that of any of the others; and that if, from this point, the quantity of the substance be progressively diminished or attenuated, the separate odours ought to disappear or become imperceptible one after the other." This theory is said to be verified by experience; as for example with tertiary amylic alcohol. "Starting in the reverse way with a quantity too small to be perceived by the sense of smell and gradually increasing the quantity, the following series of sensations are perceived: $\frac{10}{10000000}$ of a gramme, odour of benzene and isomylic alcohol: $\frac{2000}{10000000}$ of a gramme,—a camphoraceous odour. At length, on increasing the quantity, an alcoholic odour is perceived, which is not, strictly speaking, an odour at all, but an impression on the nervous system generally, and which overpowers the preceding impressions. An analogous succession of impressions is produced by a great number of bodies, such as benzaldehyde, benzylchloride, &c. Most perfumes which are pleasant when smelled in small quantity, are extremely unpleasant when in bulk. This observation holds good in a great number of instances, the bodies possessing—1°, an agreeable perfume which is not very intense, and which alone is perceived when the quantity is minute; 2°, an odour which is very intense and unpleasant, and which masks or overpowers the perfume when a larger quantity of the body is smelled. These peculiar variations in the quality of an odour are well known to persons who are accustomed to handle perfumes." Some of the points mentioned by Passy in the Memoire above quoted, are recognised facts, but others require confirmation by experiment. Certain it is that pure otto of *Rosa centifolia* in bulk is unpleasant because it is overpowering, but either in bulk or in a very dilute state, it is always the *same*, and does not remind of anything else, hence it is pure; it is also inimitable. The odours of most flowers can be imitated by

judicious combination of others; the most difficult to imitate by a blend of natural essences is the jasmin (if it can be imitated at all), but yet the impression it makes on the olfactory nerve is not a simple one, as in the case of *Rosa centifolia,* but it reminds in an indescribable way of certain organic compounds occasionally produced in the laboratory.

The compound nature of the perfume of orange-blossom, which has hitherto been considered to be a simple odour, has been proved by the researches of Mesnaud (Recherches sur le mode de production du parfum dans les fleurs, Note de E. Mesnard, présentée à l'Académie par Duchartre*). The investigation was conducted in the Botanical Laboratory of the Sorbonne, under the direction of Gaston Bonnier. Mesnard's interesting and suggestive memoir may be abstracted as follows, the passing comments inserted between brackets being my own :—

"The imperfection of the micro-chemical methods usually employed has hitherto prevented an exact knowledge being obtained of the manner in which the perfume of flowers is generated (and localised in the flower). In this particular investigation I have followed the same method of research which was adopted in the localisation of fixed oils. The method is as follows :—The section being placed in a drop of pure glycerin is arranged upon a round cover-glass, which being then inverted, serves as a cover to a small chamber formed by cementing a glass ring to an object-slide. In the interior of this chamber is fixed another ring of smaller diameter, and somewhat less in height, thus forming an inner annular space in which the reagent may be placed. By adopting this arrangement the light passing through the central part of the cell is not weakened. The inner ring further serves to support a very small cover-glass upon which sections may be arranged which require to be exposed to the action of the reagent for some length of time, as occasionally happens in the case of fixed oils. The reagent invariably employed is pure hydrochloric acid, the hydrated acid vapors abundantly given off from which are absorbed with avidity by the glycerin. In this way, by a gentle and easily regulated action, I obtain complete hydration of sections in the presence of an acid. After a few moments of exposure to the presence of the reagent, the essential oils appear as minute

* Comptes Rendus, 21st Nov., 1892, cxv., p. 282.

spherical drops of a fine transparent golden yellow. If the action be prolonged, the drops disappear, being transformed into diffusible products. The disappearance or diffusion of globules of fixed oils never takes place, the process thus furnishes a means of distinguishing these two classes of products.

"As regards the localisation of essential oils in the parts of the flower, the following observations have been made:—

"*Jasmin.* In this flower the oil is situated in the row of epidermal cells on the *upper* side of the sepals and petals. Some exist also in the corresponding layer on the under surface, where the sepals are coloured by a violet pigment. If the evolution of the cell-contents in flowers at different stages of development be followed, at first nothing but chlorophyll is found in the tissue; tannin is the next to appear, or rather intermediate glucosides, difficult to identify by means of the ordinary tests for these substances. These glucosides furnish the tannin and pigments of the lower surface of the sepals. The hydrochloric acid vapours furnish a means of distinguishing all the tannoid compounds intermediate between the chlorophyll and tannin, or pigments, on the one hand, and between the chlorophyll and essential oil on the other. The explanation of these facts seems to be as follows:—Whereas, upon the lower surface, which, in the bud, was exposed to the action of light and the oxygen of the air, the tannoid compounds were slowly oxidised, thereby generating tannin, the *upper* surface, on the contrary, being then hidden inside the bud, these agencies were inoperative (the parts not being exposed to the action of light and oxygen), and the same compounds were converted into essential oil, which oxidises when in contact with air, and so produces the sensation of perfume."—[This confirms the theory of Liebig and others, that perfume is the result of eremacausis.]

"*Rose.* The essential oil of rose is found in the papilliform epidermal cells on the upper surface of the petals, scarcely ever on the lower side."—[Blondel states* that the otto is secreted in cells on both its surfaces, those of the upper epidermis being of a papillary form, and those of the lower of an elongated cubic form.

* Produits odorants des Rosiers et Bull. de la Soc. Bot. de France, Feb., 1890.

See also series i., p. 26.]—"It is plainly evident that this oil is generated in the same manner as in the preceding case (that of Jasmin).

"*Violet.* The oil is here similarly located. It is necessary, however, in this instance, before applying the reagent, to immerse the section for a few minutes in a solution of tungstate of sodium, in order to precipitate the tannin. The essential oil then appears of a bright red colour.

"*Tubereuse.* In this case the essential oil is located on the *lower* surface of different parts of the perianth. The intermediate cells contain a fixed oil, and the presence of tannin is scarcely traceable. Thus, in consequence of the abundance of chlorophyll in the first place, of the almost complete absence of tannin, also probably by reason of the presence of a fixed oil which has drawn it towards the periphery, the essential oil is carried towards the lower surface. The intense odour of tubereuse only commences to reveal itself when the oil is enabled to form itself into small drops under the influence of the reagent.

"*Orange blossom.* The reagent discloses the presence of several distinct essential oils in the orange blossom. First there is that contained in the secretory glands, which occur on the lower surface of the petals or sepals. This is not pure neroli, as is generally supposed, but an oil analogous to that of petit-grain."—[Mesnard evidently overlooks the fact that neroli is not a true odour of orange blossom, such as is obtained by a cold process of extraction, but a modification thereof, the modification being wrought by the action of heat and contact of the molecules of oil with aqueous vapour—the product being very inferior in fragrance.]—"By skilfully eliminating these glands in an unopened bud, the agreeable odour of the flower when it afterwards expands is in no degree injured. Essential oil is also found in the epidermis of both surfaces of the petals and even upon the periphery of the petaloid filaments of the stamens. By systematically preventing in various ways the liberation of the perfume in these different parts of the flower, I have been able to ascertain that the odour corresponding to the finest neroli is solely produced on the upper surface of the petals, and I have proved that the odour of this flower is a compound one.

"The conclusions to be drawn from these researches are:—

"1°—That the essential oil is generally found localised in the epidermal cells in the upper surface of the sepals or petals, though it may exist upon both surfaces, especially if the floral organs are completely hidden in the bud. The lower surface generally contains tannin or pigments derived from it.

"2°—The essential oil seems in all cases to be the result of a transformation of the chlorophyll. This transformation is readily understood if it be admitted, as it generally is, that the floral organs are but leaves modified for the performance of a new function. The chlorophyll being thus diverted from its original purpose or use, is transformed into permanent tannoid compounds or into essential oils.

"3°—The liberation or disengagement of perfume from the flower only becomes perceptible when the essential oil is sufficiently freed from the intermediate compounds which generated it. Its formation is to some extent in inverse proportion to that of the tannin and colouring matters in the flower. This will explain why flowers with green petals possess no odour,"—[This observation is not quite correct; the flowers of the vine, for instance, are green, but they are strongly scented: their perfume approaches that of the mignonette (as does the "ferment oil" of the leaves of the vine, which is suggestive). The flowers of *Uvaria dulcis*, *Cananga odorata* and *Michelia Champaca* are of a greenish-yellow in the countries where they naturally grow, but when grown in England their flowers are of a sickly green colour, by reason of lack of sunlight, but yet they are odoriferous.]—"and why white or pink flowers are most frequently odoriferous;"—[It has been found that the order of rotation in which perfumes are generated in flowers, in respect to their colour, is as follows:—White, Yellow, Red, Blue, Green, Orange, Brown.]—"why the *Compositæ* are so rich in tannin,* and why the cultivated white lilac and forced roses acquire a very fine perfume."—[This also is a weak inference. The perfume of white lilac and white heliotrope can hardly be considered finer than that produced from the same plants growing in the free air and attaining their natural colours. Some perfumes which are rank when produced from flowers grown in the open air

* Rev. Gen. de Bot., ii., p. 391.

are certainly more pleasant when produced by flowers grown in the dark or in a confined atmosphere, because we perceive them in a milder and more bearable degree. Also the statement that the perfume of the Rose is improved by forcing the plant is extremely doubtful. In England the Rose never attains its perfection and full strength of perfume under any circumstances; the quality and maximum of perfume is only attained in climates where the plant has the benefit of the full power of the sun.]

Wintergreen.

The common names Wintergreen, Mountain Tea, Tea-berry, Checker-berry, Partridge-berry, Box-berry, Spice-berry, Jersea Tea, and Ground Holly, are applied to the **Gaultheria procumbens** Lin., sp. pl., ed. i., p. 395. The best figures of this plant, which belongs to the Order *Ericaceæ,* are given in Andrews' Botanical Repository, t. 116; Curtis' Bot. Mag., t. 1966; Bentley and Trimen, Med. Plant., t. 164; Loddiges' Bot. Cab., t. 82; Duhamel, Traité des Arbres, i., p. 286, t. 113.

It is a small creeping shrub growing in shady woods, on sandy soil, especially in mountainous districts in the southern parts of Canada and the northern United States, extending as far south as North Carolina. It is especially abundant in the pine-barrens of New Jersey. It was introduced into England in 1762, and is quite hardy here, flowering and fruiting almost throughout the year.

The cultivation of the Gaultheria is very simple; it can be propagated by setting the seeds or dividing the roots. In the natural state it spreads very rapidly, new shoots and rootlets starting from every joint of its creeping root, to say nothing of the seeds it drops. The soil it most prefers is a sandy loam mixed with peat or bog-earth, and with plenty of moisture and shade it forms a very handsome plant.

It has a long, prostrate, very slender stem, with brown scaly bark, giving off root fibres below, and above numerous erect branches, 3-6 inches high, naked and glabrous below, downy and crowded with shining, evergreen, oval leaves above. The flowers are drooping, white, of waxy appearance, produced singly from the axils of the leaves; they are slightly tinged with pink and borne

on red stalks. The fruit which succeeds them is a bright crimson-red, berry-like and sub-globular, the exterior being formed by the enlargement of the fleshy calyx which encloses the true fruit, which is a thin-walled, 5-celled capsule. The seeds are numerous, attached to the axis, small and slightly reticulated on the surface.

All parts of the plant possess a pleasant, peculiar, aromatic odour, and yield on distillation the oil known as "oil of wintergreen," which is largely used in combination with other oils in perfumery. A similar oil is yielded by the bark of *Betula lenta* (Black Birch), known in Pensylvania as "Sweet Birch, and owing to the difficulty experienced in procuring pickers for the wintergreen leaf the distillation of oil from this plant is almost entirely superseded by that of the Birch.

The **Betula lenta** is known to attain a height of 75 feet, but as generally found its height is from 10 to 25 feet. Its leaves are ovate or oblong-ovate, more or less heart-shaped at the base, accuminate, sharply and finely double serrate; when mature shining and bright green above, and glabrous, except on the veins beneath. It is found in moist woods from New England northwards to Illinois, and along the Alleghany regions southwards. As described by Kennedy* and by Breisch† in selecting a locality for the establishment of a distillery of this oil, two things must necessarily be taken into consideration, first that the material is at hand in such abundance that the supply may not soon be exhausted ; second, that there is a good supply of water. Not only the bark, but the whole tree is used, especially the saplings, except a few small sprouts near the ground, which, if left, will in five years have attained a height of 8 to 10 feet ; this height is considered quite large enough to cut. It will be observed that from the stumps of trees cut this year a new growth will have formed and be ready to cut in five years hence, and so on every five years, therefore this industry does not involve the destruction of the trees as one would suppose. The small trees are preferred ; the labourer who gathers them is paid about 3 dollars per ton delivered, and the owners of the land are paid one dollar per ton for the privilege of cutting the trees. The greatest yield is

* American Journal of Pharmacy, Feb., 1882.

† Ibid, Dec., 1891.

obtained from wood cut in the summer months. The wood is cut into lengths of from one to six inches by a chopping machine; this consists of two strong, heavy knives about eighteen inches long and three to four inches wide, fastened to one end of a shaft, the other end being connected by a wheel and belting with a water-wheel. The wood is pushed under the knives by hand, through a box or trough similar to that of a chaff-cutter. For every revolution of the shaft the knives make four cuts, and it requires but a short time to cut a ton of the material. The still consists of a heavy wooden box, eight feet long, four feet wide and four feet deep, with a copper bottom and stayed by bolts. The head of the still is of copper. The whole affair rests on a stone foundation 15 to 18 inches above the surface of the earth, a place being made for a fire; wood alone is used for fuel. The still is filled with the pieces of birch to within twelve inches of the top, and sufficient water is let in to cover it. This is allowed to macerate from eight to twelve hours; the fire is then started and the distillation carried on for eight and sometimes ten hours, but during the first two hours 90 per cent. of the oil has passed over. As the liquid comes from the condenser (which is of the common type) a novel contrivance is used for collecting the oil: this consists of a 2-quart fruit jar, fitted with a cork having two holes; a small funnel is put into one of the holes so that the end of it is about two inches below the bottom of the cork, and connected with the other hole is a suitable pipe forming an outlet. The distillate passes through the funnel into the receiver, where the water and oil separate, the oil going to the bottom, being heavier, and the water flowing away through the pipe into a larger receiver, where it is reserved for the maceration of the next quantity of birch to be distilled. When the distillation ceases, the crude oil, containing a little water and fragments of vegetable matter, is emptied into a can with a broad flat spigot fastened as close as possible to the bottom; the impurities float on the surface and the clear oil is then drawn off through the spigot. The oil is afterwards rectified. The oil is also distilled by placing the material in a wooden vat and passing steam through it from a separate boiler.

Wintergreen oil and Birch oil is now distilled on a large scale in new Jersey by chemists who, by employing a modern system of distillation, obtain a finer product, a *perfectly colourless* oil, and also

sell it pure. Some of the Canadian distillers refuse to describe their methods of rectifying the crude oil, and others describe three ways of clearing it—decolorisation, filtration and redistillation; the decolorisation is said to consist in putting the oil in a bottle, adding a few crystals of citric acid and agitating occasionally until the oil is colourless or nearly so.

There are three layers of bark on the wood. The outer thin tissue contains no oil; the next, or middle layer, is of a greenish colour and likewise contains no oil; the inner layer, next to the wood, which is much thicker than the others and more spongy, contains the oil. Some distillers use the gaultheria plant exclusively, others mix it indiscriminately with the birch, and by some the birch alone is used. It is according to the relative abundance of the material in the locality. The yield from the gaultheria fresh leaves, in an air-dry condition, has been ascertained to be 2 per cent., but it varies according to the time of collection. By the crude method of distillation employed by settlers in the woods, the yield is only 0·5 to 0·8 per cent. The yield of oil from the birch, distilled by the usual primitive methods, varies from 0·2 to 1 per cent. The yield is most abundant during the months of July and August. Of course the percentage of yield varies with the proportion of the bark to the wood in the charge. The former plant is considerably more expensive to gather, costing at the lowest calculation about thirty dollars per ton, the labour being very tedious and the labourer earning, at that rate, scarcely sufficient to live on.

The oils from the two plants are both being marketed as "Wintergreen oil," and both are subjected to systematic adulteration with petroleum, &c.

The pure oil of wintergreen is mobile, refractive and quite colourless, but it darkens by age if kept in the light in a bottle which is frequently opened. It consists mainly of *methyl salicylate*. Although it was formerly believed to contain 10 per cent. of light oil or "light ring," which was lost or washed away with the waste water in the careless process of distillation adopted in the woods, it now appears that the originator of the statement (named below) that it contains 10 per cent. of light oil either made a mistake or experimented upon a sample which was adulterated with nearly 10 per cent. of turpentine (which is most likely). An elaborate

investigation of the constituents of the leaves of *Gaultheria procumbens*, Lin., was made in 1888 by Professor Dr. Frederick B. Power jointly with Norbert C. Werbke,* which is of such interest and high authority that extracts from their Report read before the chemical section of the American Association for the Advancement of Science, 16th August, 1888, may here be given :—

" . . . Some difference of opinion prevails regarding the exact relation of this oil to the oil of the Sweet or Black Birch (*Betula lenta*, Lin.), and but comparatively little is known of the properties of one of the constituents of the former, viz., the terpene. As is well known, the first extended investigation of Wintergreen oil was made by Proctor,† but its more exact composition was first determined by Cahours,‡ who not only ascertained the presence of methyl salicylate, but was likewise the first to observe and mention the presence of an accompanying terpene . . . According to Cahours,§ Wintergreen oil contains 90 per cent. of methyl salicylate,

$$C_6H_4 \left\langle \begin{matrix} OH \\ COOCH_3 \end{matrix} \right.$$

(not the isomeric methyl-salicylic acid

$$C_6H_4 \left\langle \begin{matrix} OCH_3 \\ COOH \end{matrix} \right.$$

as is frequently and erroneously stated), and 10 per cent. of a hydrocarbon or terpene, to which the name *gaultherilen* has been applied. In his investigations the oil was distilled with concentrated aqueous potash, and the distillate, consisting of wood-spirit (methyl alcohol), water and gaultherilen, washed first with water containing potash, then with pure water, and the undissolved oil dehydrated with calcium chloride and rectified over potassium.

This terpene, or gaultherilen, is stated to be colourless, mobile, lighter than water, and to possess a rather agreeable peppery odour. Its composition is given as $C_{10}H_{16}$, with which the

* Pharmaceutische Rundschau, Sept., 1888.

† Amer. Journ. Pharm., xiv., p. 211, and xv., p. 241.

‡ Ann. Chim. Phys. [3], x., p. 358.

§ Ibid., and Gmelin's Handbook of Chem., Cavendish Edit., xiv., p. 290.

recorded analytical data well accord, while its boiling point is stated to be at 160° C., and its vapour density 4·92 (calculated for $C_{10} H_{16}$, 136 = 4·71). In Fehling's "Neues Handwörterbuch der Chemie," iii., p. 343, it is recorded, evidently as the result of a more recent observation, that the vapour density of this body is 4·74 (in still closer agreement with the calculated number), also that H Cl is abundantly absorbed by it, forming a liquid of a camphor-like odour which boils at 185° C.

It is certainly very interesting that a body possessing a pepper-like odour, as described by Cahours, should be associated with so fragrant a compound as methyl salicylate in the natural oil of wintergreen, and the writers of the above-mentioned Paper, availing themselves of an opportunity afforded them of obtaining "a perfectly pure" oil of wintergreen direct from the distiller, R. A. Wilson, of Black River Falls, and having themselves prepared a specimen of the oil from a choice quality of the winter-green leaves, isolated the terpene therefrom, with a view of testing the accuracy of previous statements respecting its physical and chemical properties." Two hundred grams of pure oil of winter-green were therefore mixed with 60 grams of caustic soda and 200 grams of water, and boiled for about five hours in a flask provided with a reflux condenser, when complete saponification of the ester was effected. The liquid was then further diluted with water and distilled until globules ceased to come over, and the first distillate treated in a similar manner, in order that any terpene dissolved by the water might be separated to the greatest possible extent. A bright yellowish oil, lighter than water, was thus obtained, which was dehydrated by means of potassium carbonate. The total amount of this body from 200 grams of the original oil was only 0·62 gram, or 0·31 per cent." (being almost precisely the same as that found by Pettigrew*). "The liquid obtained by us, which we must consider to be the terpene or gaultherilen of Cahours, possesses a pungent, pleasantly aromatic odour, but also strongly recalling that of black pepper. This odour is most apparent when the liquid is diffused by rubbing it on the hand, or when mixed with water, as in the original distillate. Its specific gravity, as accurately as we can determine it with the small amount available, is 0·940, and it does not appear to fulminate in contact with

* Am. Journ. Pharm., 1884, p. 266.

powdered iodine. When one or two drops of the liquid are dissolved in about 50 drops of glacial acetic acid, and a drop of concentrated sulphuric acid is added, it affords a pinkish coloration, but not the handsome violet colour described by Wallach* as characteristic of the sesquiterpene $C_{15} H_{24}$. This, however, does not detract at all from the possibility of its having the molecular composition $C_{10} H_{16}$, which the body in question undoubtedly possesses, since oil of turpentine, as well as some other similar oils, does not afford the above-described reaction. These results serve to confirm the statement that a body corresponding to the Gaultherilen of Cahours is present in oil of Gaultheria, although in very much smaller amounts than has hitherto been generally accepted. They also serve to prove that upon the presence of this body depends the difference between the oil of Gaultheria and the oil of Sweet Birch; for, whatever may be the varying character of these oils as found in commerce,† we are convinced that the pure oil of Birch, as determined by Pettigrew,‡ under the supervision of one of us (Power), consists of pure methyl salicylate."

According to the above mentioned observers, the sp. gr. of pure oil of Birch is 1·1819 at 15° C., and that of oil of Gaultheria 1·1759 at 15° C. Messrs. Schimmel have determined the sp. gr. of Wintergreen oil at 1·189 at 10° C., 1·185 at 15°, and 1·182 at 20° C.,§ and more recently|| caution buyers against oils of lower sp. gr. less than 1·180, stating the sp. gr. of pure methyl salicylate to be 1·1870 at 15° C. It is stated by Pettigrew¶ that a "pure oil of Birch" was found by him to boil at 218° C. Power and Werbke state that "an authentic specimen" of oil of Gaultheria was found by them to "distil quite constantly at from 215° to 216° C."

Cahours, in 1843,** found that methyl salicylate could be prepared artificially by distilling a mixture of 2 parts of

* Liebig's Ann. der Chemie, 1886, p. 87.

† Squibb's Ephemeris, iii. (1887), p. 953.

‡ Am. Journ. Pharm., 1883, p. 385.

§ Bericht., April, 1887.

|| Bericht., October, 1890.

¶ Am. Journ. Pharm., 1884, p. 266.

** Ann. Chem. Pharm., xlviii., p. 83, and liii., p. 327.

salicylic acid, 2 parts of anhydrous wood spirit and 1 part of sulphuric acid. This artificial methyl salicylate is not considered by some to possess a fragrance equally fine to that of the natural product, but that is a matter of opinion, or it may be due to the fact that salicylic acid of commerce, which is used in its manufacture, is not pure, but contains from 0·5 to 1 per cent. of cresotic acid (being made from phenol).* The sp. gr. of *synthetic* wintergreen oil, when quite pure, prepared from salicylic acid absolutely free from cresotic acid, is found by Messrs. Schimmel to be 1·1870 at 15° C., and its boiling point 219° to 221° C. This sp. gr. pertains to an oil entirely free from water. The oil of commerce, which is distilled with water-steam, generally contains, as is well known, small quantities of water, which cause some variations in the third decimal place.

For the detection of free salicylic acid in synthetic methyl salicylate, Schneegans and Gerock observe as follows :—The violet colour resulting from the mixture of 10 c. c. of a 0·2 per cent. solution of salicylic aldehyde with 2 c. c. of a very dilute solution of perchloride of iron, may be removed by shaking it with 5 c. c. chloroform or ether. But if only 0·0002 gram. of salicylic acid be added, the violet colour remains persistent. A similar reaction occurs with the methyl ester of salicylic acid, and it may be used to detect as little as 1 in 500 of free acid in artificial oil of wintergreen.†

The Wintergreen oil of commerce is largely adulterated with *Methyl benzoate*,‡ and if the odour of the compound is not sufficient to indicate the presence of it, it may be suspected and tested for by reason of low sp. gr : that of methyl benzoate being 1·095 at 15° C.

Pure oil of *Gaultheria procumbens* is said to rotate slightly to the left (about —2° in a 200 m. m. tube), whilst pure oil of *Betula lenta* and pure methyl salicylate are both optically inactive.

American pharmaceutical journals have recently attempted to establish a test to distinguish between natural and synthetical

* The assay of artificial salicylic acid is described by Ewell and Prescott, Pharm. Journ. [3], xix., p. 328.

† Pharm. Journ. [3], xxii., p. 609.

‡ Series i., p. 238 ; the sp. gr. should there have been stated to be 1·095 at 15° C.

wintergreen oils, depending upon variations in their power of dissolving Fuchsine (Aniline red). The greater solubility of fuchsine in the artificial oil is erroneously ascribed to the presence of methyl alcohol. However, as fuchsine is soluble in methyl salicylate, and as the natural oil, besides this body, contains Terpene, which does not dissolve fuchsine, the solvent power of the natural oil is consequently less than that of the artificial. The difference is, however, owing to the small percentage of terpene present, not important enough to distinguish the two products from each other, much less to recognise a mixture of them, and accept it as a test. Oils which are abundantly adulterated with Kerosene, paraffine oil or turpentine will have a conspicuously less solvent power for fuchsine.* This fact is sufficient to characterise the test as worthless.

It is considered by Dr. Power (the most eminent authority on Wintergreen oil known) that the detection of sassafras oil with nitric acid, according to the instructions of the United States Pharmacopœia, may lead to false results, and he formulates a test based upon his own observations, as follows:—

"To 1 c. c. m. of the Wintergreen oil, Birch oil or synthetical methyl salicylate, under examination, 5 c. c. m. of a 5 per cent. sodium hydroxide solution are added, and the mixture shaken together in a large test-tube. A voluminous white crystalline precipitate is formed, and if the corked tube be placed in hot water and frequently shaken for about five minutes, solution ensues, and the contents must show a clear colourless or slightly yellowish liquid, with no separation of oily drops either on the surface or at the bottom of the solution. This is a proof of the absence of other essential oils and petroleum. If the solution is then diluted with three times its volume of water and slightly acidulated with hydrochloric acid, a white crystalline precipitate is formed, which, collected upon a filter, washed and re-crystallised out of hot water, should answer all the tests for pure salicylic acid—showing the absence of methyl benzoate, &c."

Dr. Power has convinced himself that in the above manner admixtures of 5 per cent. of sassafras or camphor oils can be readily detected, not only by the separation of visible oily drops,

* Power, in Pharmazeutische Rundschau, 1889, p. 283.

but also by the odour, as the charateristic odour of the oil of wintergreen disappears completely during the process.

A fictitious oil of wintergreen has been met with containing large quantities of oil of sassafras and of chloroform. A mixture of 4 parts of oil of sassafras and 1 part each of chloroform and oil of wintergreen has a sp. gr. nearly the same as oil of wintergreen. The presence of chloroform can easily be detected by shaking the mixture in a moderately warmed test-tube, when the odour of chloroform will be perceptible; by fractional distillation, between 60° and 70° C., the chloroform can be separated. The residue treated with nitric acid will show the presence of oil of sassafras by turning it dark red.*

A plan for the volumetric estimation of Methyl Salicylate in oil of Wintergreen and Sweet Birch of commerce has been devised by B. H. Ewing (of Ewingville, Ohio), and the results communicated in a paper read before the American Pharmaceutical Association. It consists in saponifying a weighed portion of the oil with an excess of normal solution of soda and neutralising the excess with normal hydrochloric acid; in detail it is as follows:—Weigh 5 grams of the oil in a tared flask of 100 c. c. m. capacity, and pour upon it 40 c. c. m. volumetric solution of soda. Cork the flask securely and heat the contents at 60° C. until the precipitate formed at first has totally disappeared. Cool, remove the cork, and again apply and maintain heat at the boiling point for five minutes: again cool, add enough solution of phenolphthalein to impart a red colour, and then enough normal hydrochloric acid to render the liquid neutral, as will be sharply indicated by the disappearance of the red colour. Subtract the volume of acid required from 40 and multiply the remainder by 0·138 (one-thousandth of the molecular weight of salicylic acid), and the resulting product by 20 to get at the percentage of salicylic acid; or multiply the remainder by 0·152 (one-thousandth of the molecular weight of methyl salicylate) and the resulting product by 20 to get at the percentage of methyl salicylate.

This method was applied to three specimens of oil, the following table showing the results compared with those obtained by a gravimetric method:—

* Jacobsen's Chemisch-Technisches Repertorium, p. 268.

SPECIMEN.	VOLUMETRIC. SALICYLIC ACID.		VOLUMETRIC. METHYL SALICYLATE.
1.—Genuine oil of Gaultheria	90·15%	=	99·30%
2.—Genuine oil of Sweet Birch...........	90·20 „	=	99·40 „
3.—Commercial oil of Wintergreen	90·15 „	=	99·30 „

SPECIMEN.	GRAVIMETRIC. SALICYLIC ACID.		GRAVIMETRIC. METHYL SALICYLATE.
1.—Genuine oil of Gaultheria	89·56%	=	98·65%
2.—Genuine oil of Sweet Birch...........	90·54 „	=	99·72 „
3.—Commercial oil of Wintergreen	90·65 „	=	99·85 „

"Three more specimens of the commercial oil obtained from different manufacturers of natural salicylic acid, were estimated, by the volumetric method, one of which proved to be absolute methyl salicylate, the other two 99·10 per cent. and 99·50 per cent. respectively. The method has since proved effective in one instance in detecting an oil offered for sale by a travelling broker, which contained only 68 per cent. of methyl salicylate."*

The assay of essential oils by saponification formed the subject of an interesting communication read before the Pharmacy Section of the Naturforscher Society at Cologne by Kremel, in which it was proposed to utilise the differences in the behaviour of essential oils towards alcoholic potash solution as a means of determining their identity and purity.† The author stated that he had applied this test to a large number of essential oils, with the following general results:—Genuine rose oil contains scarcely any saponifiable constituent, but eight or ten samples of geranium oil, from different countries, each gave tolerably high saponification numbers. Lavender oil gave very high saponification numbers; lemon oil, on the contrary, did not. Artificial bitter almond oil gave higher saponification numbers than the natural oil, and upon decomposing the saponified mass from the latter with acids, a crystalline precipitate was formed, amounting to 40 or 50 per cent. of the oil used. A

* Pharmaceutical Record.

† Pharm. Centralh., 4th October, 1888, p. 482.

similar precipitate was formed, but in smaller quantity upon decomposing the soap from peach kernel and other similar oils, but not from the soap of artificial bitter almond oil.

The gravimetric method of assay was conducted as follows :—A small, convenient quantity (1·5 to 2 grammes) was weighed in a tared flask of 50 c. c. m. capacity, a slight known excess of a strong solution of caustic soda added, the flask securely corked and the contents rotated over a moderate heat until the disappearance of the precipitate formed by the soda solution. After cooling, the cork was removed, and the liquid again subjected to heat for five minutes, this time at the boiling point, after which it was transferred to a separating funnel, where it was treated with a slight excess of hydrochloric acid, and the precipitated salicylic acid taken up by shaking the resulting mixture with two volumes of ether. After subsidence, the aqueous stratum was drawn off into a second separator and shaken with two volumes of ether ; again drawn off into a third separator and shaken with two volumes of ether: when, upon resting, the aqueous solution was finally drawn off, found to be free from salicylic acid, and rejected. The ethereal solutions in the separators were then washed in succession four times, each time with two volumes of distilled water, to free them from sodium chloride. That in the first separator was transferred to a tared platinum dish, as was that in the second, after passing through the first, and that in the third after passing through the second, and thence also through the first. The ethereal liquids were carefully evaporated and the residue dried over sulphuric acid to a constant weight.*

Ethyl salicylate can be obtained by distilling a mixture of 2 parts of absolute alcohol, 1½ part of pure salicylic acid and 1 part of sulphuric acid. The first product consists almost entirely of alcohol, a mixture of alcohol and salicylic acid then passes over, and lastly the bulk of the ethyl salicylate formed. The distillation must be stopped when a disengagement of sulphurous acid is observed. The product is washed with water rendered slightly ammoniacal, then dried over calcium chloride and rectified. Ethyl salicylate is a colourless, fragrant liquid of sp. gr. 1·1345 at 15° C., boiling at 231° to 232°·5. It is but very slightly soluble in water, but in combination with potash or soda forms crystalline compounds which are soluble in water.

* British and Colonial Druggist, 9th Sept., 1892, p. 280.

Phenyl salicylate. This ethereal salt, known as *Salol*, was first obtained by Seifert* by heating salicylic acid and phenol with phosphorous oxychloride. A better yield is obtained by employing the sodium salts, and it is now manufactured by heating the product of the action of carbon dioxide on sodium phenate with phosphorous pentachloride or oxychloride. Salol crystallises in rhombic prisms which are odourless and melt at 42°-42°·5; the dilute alcoholic solution, however, has an odour resembling that of wintergreen oil. It is used in medicine as a substitute for salicylic acid, over which it possesses many advantages in this respect.

In the preparation of Salol from salicylic acid and phenol, or from sodium salicylate and phenol-sodium, instead of subjecting them to the action of phosphorous oxychloride or pentachloride, the acid sulphates of the alkalies may be used.† These exercise a strong dehydrating action, salol being formed. As solvents and diluents benzene and toluene are used, being recovered by distillation. The reaction follows a similar course when dioxynaphthalin or gaultheria oil takes the place of phenol. It has been suggested that these improvements in the manufacture of salol may open the way for the preparation of a large number of similarly constituted organic compounds.

Methylsalicylic acid was first prepared by Gräbe‡ in the following manner :—Two parts of methyl salicylate are heated to 100°-120° C. with one part of caustic potash and three or four parts of methyl iodide, the product distilled in order to remove methyl alcohol and methyl icdide, and the residue then extracted with caustic soda and precipitated with hydrochloric acid. Any adhering salicylic acid is removed by boiling with an excess of milk of lime, insoluble basic calcium salicylate being precipitated, while calcium methylsalicylate remains in solution and is then decomposed by hydrochloric acid. Methylsalicylic acid crystallises from hot water in large, monoclinic tablets, and from alcohol in prisms, which melt at 98·5 and decompose above 200° C. into carbon dioxide and *anisol*. On heating with concentrated hydrochloric acid, it is resolved into salicylic acid and methyl chloride. Cahours obtained

* Journ. Prakt. Chem. [2], xxxi., p. 462.

† Pharm. Centralhalle, 25th Oct., 1888, p. 530.

‡ Ann. Chem. Pharm., cxxxix., p. 137.

the methyl ether of this compound, by the action of methyl iodide and caustic potash on wintergreen oil; it is a liquid boiling at 244°-246° C.

Salicylic acid, $C_7 H_6 O_3$, can be obtained in purity from natural oil of wintergreen by the following process:—Dissolve three parts of pure caustic potash in 2 parts of water in a glass or porcelain vessel, and raise the temperature to 180° Fahr. Stir into this gradually 3 parts of wintergreen oil, using a glass or porcelain spatula. Into another vessel place 64 parts of cold distilled water and add 8 parts of hydrochloric acid, then, with constant stirring, add the salicylate of potassium. The magma of minute crystals of salicylic acid which forms must be separated with a thin muslin strainer (previously moistened) and pressed, then dried by exposure to a temperature of 150° Fahr. The yield of this crude acid will be slightly over 2 parts. Dissolve this in 6 parts of cold alcohol and filter through a funnel stopped with cotton. Then, with constant stirring, pour the filtrate into 32 parts of cold water. The magma of minute crystals must be separated with a thin muslin strainer and dried by exposure to a heat of 150° Fahr.

It was long ago observed by Gerhardt that salicylic acid decomposes on heating into phenol and carbon dioxide. Salicylic acid is now manufactured in a wholesale way synthetically by Kolbe and Lautemann's patented process, *i.e.*, by the action of carbon dioxide on a mixture of phenol and sodium*; English Patent No. 595, 1874. The former chemist found that it was also formed when carbon dioxide is passed over heated sodium phenate, half the phenol being set free.† There are also other ways of preparing it synthetically.

Other Ericaceous plants are known to yield oils analogous to that of *G. Procumbens*; such as, **Gaultheria leucocarpa**,‡ a native of Java and very common in woods on the summit of Mount Gede, Mount Patoea and other extinct volcanoes. It is known by the natives under the name of *Zantigi badas*. This plant was found by De Vrij§ to yield from the fresh leaves 0·012 per cent. of essential

* Ann. Chem. Pharm., cxv., p. 201.

† Journ. Prakt. Chem. [2], x., p. 89; described in 1st series, p. 166.

‡ Blume, Bijdragen tot de Flora van Nederlanche Indie, p. 856.

§ Pharm. Journ. [3], ii., p. 503.

oil which was examined by Köhler* and found to consist almost entirely of methyl salicylate.

G. punctata,† also a native of the same localities in Java, and known to the natives as *Tjatagie-wangie.*‡ This plant was found by De Vrij to yield 1·15 per cent. of oil, consisting of methyl salicylate and a little gaultherilene.

Gaultheria fragrantissima, Wallich, As. Res., xiii., p. 397. Wight, Icones, t. 1195-96; Bot. Mag., 1984. This shrub, called the "Indian Wintergreen," is an inhabitant of the Hills of India, Burma and Ceylon. In Nepal it is known as Sheaboogi (it is a native of Narainhetty). It is found also in Java and there known as Gandapuro. It is accurately described and figured in the "Asiatic Researches" above quoted. It is the *G. fragrans* of Don§ and the *Arbutus laurifolia* of Hamilton.

The leaves of this plant are from two to four inches long. The corollas are pale red, and very sweet-scented.

Dr. Dymock‖ says, "This ramous shrub with thick coriaceous leaves, white flowers and blue berries inhabits the grassy hills and affords an essential oil nearly identical with that of *G. procumbens.*"

Broughton (the late Government Quinologist at the Nilgiris), in a Report to the Madras Government on the subject of this oil says:—"The oil from this source contains less of the peculiar hydrocarbons which form a natural and considerable mixture with the Canadian oil, and therefore is somewhat superior in quality to the latter."

The shrub has no vernacular name on the Nilgiris and does not appear to be used by the natives, except the berries, which are eaten by the Badagas.

G. odorata, mentioned by Humboldt¶ and by Persoon,** is a

* Ber. Deutsche. Chem. Ges., xii., p. 246-8.

† Blume, loc. cit., p. 856.

‡ For the meaning of *Wangie*, see page 296, Series i.

§ Prod. Fl. Nep., p. 151.

‖ Pharmacographia Indica, ii., p. 325.

¶ Personal Narrative of Travels, i., pp. 397 and 599, and in his "Nova Plantarum Genera," iii., p. 285.

** Synopsis Plantarum, i., p. 482.

native of New Andalusia on Mount Tumiriquiri and on the southern declivity of Mount Silla de Caraccas, where it is called Pejoa by the natives; it is also found in Mexico at Cuesta Grande de Chiconquiaca. It forms a much branched shrub of 4 to 5 feet in height, with aromatic leaves 2 inches in length, glandularly ciliated while young.

Phalerocarpus serpyllifolia, the "Wild thyme-leaved Snowberry," has the same aromatic taste and smell as *Gaultheria procumbens* and is a native from Canada to Pensylvania. It has been observed north-westward of Lake Michigan and abounds where evergreens are predominant, and generally in the northern forests of pines, larches and firs, growing always amidst sphagum. It is a small, creeping plant with roundish-oval leaves and axillary, solitary, nearly sessile flowers. Its aromatic berries are white and produced in considerable quantities. It is synonymous with *Vaccinium hispidulum*, Lin. spec., 500; Michaux, Flora Boreali Americana, i., p. 228, t. 23; *Gaultheria serpyllifolia*, Pursh, Flora Americana Septentrionalis, i., p. 283, t. 13; *Arbutus filiformis*, de la Marck Encyclopédie méthodique, p. 228.

It is also recorded by Broughton, the Government Quinologist,* that the oil of *Andromeda Lechenaultii*, another of the *Ericaceæ* which grows in inexhaustible abundance on the Neilgherry Mountains in India, consists almost entirely of methyl salicylate and is almost identical with Canadian oil of wintergreen.

Salicyl aldehyde, $C_7H_6O_2$, formerly called *Salicylol*, *Salicyl hydride* and *Spyroyl hydride*, is contained in small quantity in the flower-buds of **Spirœa ulmaria**, the "Meadow-sweet," which is a very common plant in England on the banks of streams and in moist pastures and woods. The flower-buds distilled with water give a very small yield, but a larger quantity is obtained when sulphuric acid and potassium dichromate are added, thus showing that the buds contain *salicin*. To prepare it artificially, 3 parts of salicin and the 3 parts of potassium dichromate are intimately mixed, and 24 parts of water poured upon the mixture, which is then well agitated in a retort; 4½ parts of strong sulphuric acid diluted with 12 parts of water is then poured in at once and the agitation is repeated. A slight evolution of gas then takes place, lasting for half to three-quarters of an hour, the liquid

* Pharm. Journ. [3], ii., p. 281.

at the same time becoming somewhat heated and assuming an emerald green colour. As soon as this reaction has ceased, the liquid must be gently distilled. Salicyl aldehyde then passes over and condenses in the receiver in the form of a heavy oil, its formation being accompanied by the evolution of carbonic anhydride and formic acid. The distillation is continued until the condensed water is no longer milky, and passes over quite clear. If the distillation be continued too long, *furfurol* passes over, and all preparations made from the aldehyde then become intensely red-coloured on standing. The oily portion is then separated from the water and the portion which remains dissolved in the water may be extracted by agitation with ether and evaporation of the ether. The residue in the retort is chrome alum, on the surface of which there usually floats a resinous matter resulting from the decomposition of part of the salicyl aldehyde. 250 grams. of salicin thus treated, yield about 60 grams of salicyl aldehyde.

The aqueous extract of willow bark may also be used instead of pure salicin. The aldehyde thus obtain is purified by combining it with an alkali, concentrating the solution and distilling it with dilute sulphuric acid.

Salicyl aldehyde was at first mistaken for an acid (spirœic acid or salicylous acid), because it is at once an aldehyde and a phenol and therefore forms salts.

Salicyl aldehyde also occurs in the sap of various plants belonging to the genus *Spiræa*; in the stem and root of *Crepis fœtida*,* and in the larvæ of *chrysomela populi*, which lives on willows and poplars and possesses small openings along the body from which salicyl aldehyde may be pressed out in oily drops.† Enz also obtained it by distilling the beetle with water.‡

Salicyl aldehyde is a liquid with a pleasant aromatic odour and a burning, spice-like taste; it boils at 196°·5 C., solidifies at 20° C. to large crystals, and has a sp. gr. of 1·1731 at 13°·5. Its aqueous solution, even when very dilute, is coloured violet by ferric chloride and yellow by alkalies. It does not reduce Fehling's solution§ and forms difficultly soluble compounds with

* Ann. Chem. Pharm., xci., p. 374.

† Jahresber. Chem., 1850, p. 583.

‡ Ann. Chem. Pharm., 1859, p. 312.

§ Ber. Deutsch. Chem. Ges., ix., p. 824.

the acid sulphites of the alkali metals,* this property being made use of in its purification. As a phenol it forms salts, ethers and ethereal salts.

When salicyl aldehyde is agitated with strong aqueous ammonia at a gentle heat, the *salicylite of ammonium* is formed, and crystallises on cooling in yellow needles. This body is slightly soluble in water and still less in alcohol. It melts at 115° C., and volatilises at a higher temperature without alteration. When kept in the moist state in a closed vessel it gradually decomposes, blackens, becomes semi-fluid, gives off ammonia and acquires a "very penetrating *odour of roses.*"

Salicin, $C_{13}H_{18}O_7$, is the glucoside which constitutes the bitter principle of the leaves and bark of the willow. It was at first considered to be an alkaloid, but on being subjected to careful investigation by Piria, a complete explanation of its nature was arrived at.†

It occurs in the bark, leaves and female flowers of many trees which do not all belong to the willow tribe. It has been found to the extent of 4 per cent. in *salix helix, pentandra, and præcox*; has also been found in the bark and leaves of the Poplar‡; in the flower-buds of *Spiræa Ulmaria* as above described, and in Castoreum.§ ‖ Its occurrence in castoreum is explained by the fact that when taken internally a portion of it appears in the urine as *saligenin*, salicyl aldehyde and salicylic acid, the remainder being excreted unchanged, and the Castor Beaver feeds on plants which contain it. ¶

Besides its other uses, salicin is used for adulterating quinine.

Salicin can be prepared in the following way:—3 parts of chopped willow bark are exhausted three times with boiling water

* Ann. Chem. Pharm., lxxxv., p. 93.

† Ann. Chem. Pharm., xxx., pp. 151 and 189; lvi., p. 49; also Liebig, ibid., xxx., p. 185.

‡ Braconnet in Ann. Chim. Phys., xliv., p. 296, and Tischausen, Ann. Chem. Pharm., vii., p. 280.

§ Ibid., lxvii., p. 360.

‖ Laveron and Millon, Ann. Chem. Pharm., lii., p. 435, and Ranke, Jahresb. Chem., 1852, p. 711.

¶ It is remarkable that the odour of Castoreum is noticeable in the *Ferment oil* of *Salix pentandra*, a willow common in the North of England. See "Ferment oils."

(or are boiled with water), the combined extract evaporated down to 9 parts, mixed whilst still hot, and digested for 24 hours with 1 part of litharge, filtered and evaporated to a syrup. The salicin separates out and is purified by recrystallisation. An additional quantity of salicin is obtained from the mother liquors after they have again been treated with litharge and the entire product is purified by repeated crystallisation.

Erdmann's process is as follows:—16 ounces of the bark are macerated for twenty-four hours in 4 quarts of water mixed with 2 ounces of lime, and the whole is then boiled for half-an-hour. The process is repeated with the residue. The decoctions having been mixed and allowed to clear by subsidence, the clear liquor is decanted, concentrated to a quart, digested with 8 ounces of bone black, filtered and evaporated to complete dryness. The residue, after being pulverised, is exhausted at a gentle heat with alcohol of 82 per cent. On the alcohol being gently distilled off from the tincture, the salicin crystallises from the residue and is again dissolved, purified by bone black and recrystallised. By this process Erdmann obtained 300 grains of salicin from 16 ounces of *Salix pentandra* bark. The red colour imparted to salicin by strong sulphuric acid may serve for its detection in willow barks.

Salicin forms needles, plates or rhombic prisms which dissolve in 30 parts of water at the ordinary temperature, and freely in hot water and alcohol, but are insoluble in ether. It has a very bitter taste, and forms a purple-red solution in sulphuric acid. Dilute nitric acid oxidises it to *Helecin*,* which may be re-converted into salicin by sodium amalgam and water. Helecin can be prepared synthetically.† Salicin melts at 201° C., and solidifies on cooling to a crystalline mass; when it is heated, however, for some time to 230°-240° it partially decomposes into *salirctin* and *glucosane*.‡ Its aqueous solution rotates the plane of polarisation to the left.§

Populin or *benzoylsalicin*, a neutral substance discovered by Braconnet in the bark, leaves and root bark of the "Aspen Poplar" (*Populus tremula*),|| and was also investigated by Piria¶.

* Piria, Journ. Chem. Soc., lvi., p. 64.

† Michael in Amer. Chem. Journn., i., p. 309.

‡ Ber. Deustch. Chem. Ges., xiv., p. 304.

§ Ann. Chem. Pharm., clxxvi., p. 116.

|| Ann. Chim. Phys., xliv., pp. 296, 311.

¶ Ann. Chem. Pharm., lxxxi., p. 245; xcvi., p. 375.

It was also observed by Piccard, together with salicin and other substances in the buds, bark, leaves and root bark of *Populus pyramidalis nigra* and *balsamifera*.* Von Müller describes (Organic constituents of Plants) its preparation as follows:—"Boil with water; precipitate with subacetate of lead; free the filtrate from lead by sulphuric acid; concentrate, boil with animal charcoal, and allow the salicin to crystallise. The mother liquor yields with carbonate of potash a deposit of populin, which has to be recrystallised from hot water." It crystallises in white, silky, shining very voluminous needles. It much resembles salicin in appearance, but, unlike that substance, its taste is penetratingly sweet, the taste resembling that of liquorice. It loses the whole of its water of crystallisation at 100° C. It melts at 180° C., and above that temperature it decomposes, yielding benzoic acid. It dissolves in 2,420 parts of water at 15° C., and in 42 parts at 100° C.† Gerhardt says: "It dissolves in 2,000 parts of cold and in 70 parts boiling water; in 100 parts cold absolute alcohol; in boiling alcohol more readily than in boiling water, and scarcely in ether." It behaves towards concentrated sulphuric acid like salicin, and forms, on boiling with dilute sulphuric acid, benzoic acid, grape-sugar and saliretin. On heating with potassium dichromate and sulphuric acid much salicylous acid is formed. Boiling baryta decomposes it into salicin, and benzoic acid-emulsin has no action upon it.‡ By heating it with alcoholic ammonia, salicin, benzamide and ethyl benzoate are obtained. Nitric acid oxidises it to *benzoyl-helecin*, which is the corresponding aldehyde.

The composition of populin was found§ on the average of three analyses to be 56·44 per cent. of Carbon, 6·27 per cent. of Hydrogen, and 37·28 of Oxygen.

Populin has been prepared artificially by Schiff,‖ by fusing salicin with benzoic anhydride.

An oil of pleasant balsamic odour is obtained by aqueous distillation from the leaf-buds of *Populus niger* and other species of Poplar.

* Ber. Deutsch. Chem. Ges., vi., p. 890.

† Schmidt, Ann. Chem. Pharm., xix., p. 92.

‡ Schmidt, ibid.

§ Pharm. Journ., Feb., 1856.

‖ Ann. Chem. Pharm., cliv., p. 5.

An oil is also obtained by aqueous distillation from the young leaves of *Betula alba.*

The aromatic product derived from the bark of the "White Birch," *Betula alba,* is an empyreumatic oil or a decomposition product obtained by the partial combustion or slow destructive distillation of an organic constituent of its bark, the odour being usually known as "Russia Leather." It is described in the chapter on "empyreumatic oils."

SECTION II.

PRODUCTS OF FERMENTATION AND HEAT.

Ferment Oils.

The flowers and other parts of plants from which essential oils can be drawn by distillation (without any previous treatment) of course contain the essential oil ready formed and stored in glands, glandular hairs, ducts or cells. The formation of the odorous principle in some plants is continuous, in others it takes place only during the day-time, in others only at night, but the production is regarded as the result of either the decomposition or fermentation of the chlorophyll or of a saccharine juice, glucoside or other proximate principle.

In a flower, the perfume once formed, has a tendency to further oxidation, or partial fermentation, and when the flower is plucked this deterioration begins very soon and works rapidly. Such flowers as are used in the perfume industry should therefore be taken at once to the factory and operated upon immediately. The effects of this fermentation are more marked in some flowers than in others, by reason of the bodies with which the odorous principle is associated. The new compounds generated vary accordingly. The matter which in the natural way is converted into odorous principle in the living plant appears in some cases to be capable of conversion by artificial means. Liebig states* that it is a fact that very small quantities of the blossoms of the violet, elder, linden, or cowslip, added to a fermenting liquid, are sufficient to communicate a very strong taste and odour, which the addition of the water distilled from a quantity *a hundred times greater* would not effect. The various kinds of beer manufactured in Bavaria are distinguished by different flavours, which are given by allowing small quantities of the leaves and blossoms of particular plants to ferment along with the wort. This leads to the consideration of

* Chemistry of Agriculture, p. 332.

Ferment oils, bodies which are very imperfectly understood, but which are of great interest, and deserving of more careful study than has yet been given to them.

Ferment oils are volatile oils produced by the fermentation of various inodorous plants; they are not originally contained therein or previously existing, and are essentially different from the oils which are extracted from unfermented plants by distillation with water. According to Becker,* they were known to the Alchemists, and by them designated "quintessences." Ferment oils are for the most part more soluble in water than ordinary volatile oils. Berzelius regarded them as peculiar alcohols related to fusel oil and forming compound ethers with salt radicles and acids.†

Büchner first separated an oil of this nature from the fermented herb of *Erythræa centaurium* by distillation.‡

Ferment oil of **Chœrophyllum sylvestre** (Wild Chevril). The flowering plant is left to ferment in water; the liquid distilled when the fermentation is ended: the distillate mixed with common salt and shaken up with ether; the ether removed from the aqueous solution and evaporated off. The oil thus isolated is of a brownish colour, lighter than water, having a strong and peculiar pungent odour and an aromatic taste, not bitter, but rough. It is very volatile, evaporating quickly at 18° C. (therefore its separation from the ethereal solution should be conducted with care, in vacuo, and employing a freezing mixture in the refrigerator, as hereafter explained). It burns with a clear, luminous flame, diffusing a vapour which excites coughing. Chlorine water converts it into yellow flocks, retaining the odour of the oil. It dissolves in iodine. It is decomposed with violence by nitric acid. By sulphuric acid it is coloured brown without losing its odour. It forms an emulsion with aqueous ammonia; dissolves sparingly in water, easily in alcohol, ether, and oils both fixed and volatile.§

Ferment oil of **Chelidonium majus.** Obtained from the roots in the same manner as the ferment oil of *Chærophyllum sylvestre.* Has an agreeable odour like the bouquet of wine and a persistent

* N. Br. Archiv., lv., p. 161.

† Jahresbericht der Pharm., xxvii., p. 541.

‡ Repert. Pharm., liii., p. 299.

§ Bley, N. Br. Archiv., xlv., p. 50.

biting taste. It is not very volatile. With iodine it forms a violet solution. It dissolves sparingly in water, readily in alcohol, ether, and oils fixed and volatile.*

Ferment oil of **Conium maculatum.** Obtained from fresh hemlock in the same manner as the above. Colourless, has a peculiar odour not like that of hemlock, and a sharp, burning taste. It is not poisonous. Dissolves freely in alcohol, ether, and oils both fixed and volatile.†

Ferment oil of **Centaurium minus** (*Erythræa Centaurium*, "Petite centaurce"). This is perhaps the most remarkable example of the generation of a true ethereal oil from a plant destitute of odour. The plant is macerated in water at a slightly elevated temperature; after 12 hours it ferments and gives off a perceptible odour which is agreeable and penetrating. This increases up to 60 hours, and then ceases. If the fermenting vessel be connected with a condenser, the whole of the oil, which is very volatile, may be collected, but following the instructions given by the original observer for its preparation, some of the oil would be lost. They are: "Macerate the fresh herb in water for 48 hours, then distil as long as drops of oil pass over into the receiver, and rectify the distillate." The maceration and fermentation might be allowed to continue for 60 hours if connected with a condenser so that no vapours escape, and after that time heat might be applied. The aqueous distillate is pale-yellow with white turbidity; it has a persistent, enlivening, aromatic odour, which is not pleasant when close, and irritates the eyes and nose; its taste is extremely burning, like that of creosote, but not persistent. It reddens litmus, but not permanently.‡ The oil is thin and greenish, having a peculiar and agreeable odour. It is not poisonous. When heated with ammonia and nitrate of silver it reduces the silver to the metallic state.

Ferment oil of **Echium vulgare** (the common "Viper's Bugloss," a species of *Boraginaceæ* common throughout Britain). The plant in the flowering state is first macerated and fermented, then distilled. The distillate is shaken up with ether, the ether

* Bley, Ibid., xlviii., p. 156.

† Landerer, Repert. Pharm., xliv., p. 237.

‡ Buchner, Repert. Pharm., liii., p. 303.

decanted and distilled off as with the other oils. It is pale yellow, lighter than water, easily soluble in alcohol and ether.*

Ferment oil of **Erica vulgaris.** The fresh herb is treated as above, the distillate is cohobated and repeatedly distilled after addition of common salt, then shaken up with ether and the ether carefully distilled off from the dissolved oil. The oil is greenish-yellow, mobile, lighter than water, with a peculiar odour and sweet, aromatic, burning taste. It reddens litmus paper and burns with a clear, blue-edged flame without leaving any residue.†

Ferment oil of **Marrubium vulgare.** The comminuted herb is soaked in water and exposed to the sun, whereby it acquires an offensive odour; the liquid is then distilled, the distillate saturated with common salt; the flocks thereby separated are collected on a filter and dissolved in ether and the ether slowly evaporated. The oil is lighter than water, has a peculiar sweet, ethereal odour, and an aromatic, slightly biting taste. It burns without leaving any residue. "With chlorine water it emits an odour of *roses.* It dissolves in aqueous alkalies and in water."‡

Ferment oil of **Achillea millefolium** ("Milfoil" or common "Yarrow"). The fresh flowering plant is macerated in water and left to ferment; the whole is distilled with cohobation. The blue oil which floats on the distillate is removed; the residual water, after addition of common salt, is agitated with ether and the ether which separates is evaporated off. It is a yellow-brown oil having a slightly aromatic odour and an aromatic, bitter, rather sharp taste. It dissolves in alcohol, ether and oils fixed and volatile.

Ferment oil of various species of **Plantago.** The plantain leaves are macerated, fermented, and distilled as above, and the distillate exhausted with ether in the same way. It is a yellow, transparent oil with an ethereal odour and an aromatic, sweet, burning taste. It is very volatile. With fuming nitric acid it turns brown, with rise in temperature. The solution first becomes greenish-yellow, with milky turbidity, then clear, smells like artificial *musk* and has a very bitter taste. It dissolves in alcohol, ether and oils.§

* Bley, N. Br. Archiv. xxx., p. 167.

† Bley, N. Br. Archiv., xxxi., p. 302.

‡ Bley, N. Br. Archiv., x., p. 67.

§ Bley, N. Br. Archiv., xl., p. 130.

Ferment oil of **Quercus Robur** (the "Cork Oak"). Obtained from the fresh oak-leaves by fermentation, distillation and treatment of the distillate with ether as above. The oil is pale green. Sp. gr. 0·695; has an agreeable and enlivening odour, and sweet, burning taste. It reddens litmus and is easily inflammable, giving first a bluish, then whitish, non-fuliginous flame which emits a penetrating odour. With fuming nitric acid it froths up and becomes very hot, but does not lose its odour. It dissolves sparingly in water; rapidly in alcohol, ether, and oils both fixed and volatile.*

Ferment oil of **Salix pentandra.** (This willow is common in the North of England and Ireland; it is remarkable for its large glossy leaves, more like those of a Portugal Laurel than of the other willows. Its foliage is fragrant.) The oil is obtained from the fresh leaves in the same manner as above. It is yellow, lighter than water, has an agreeable aromatic odour *like that of castoreum* and, at the same time, like that of the leaves. It reddens litmus; smells strongly when heated, and burns with a very smoky flame, leaving a small quantity of charcoal.

Ferment oil of **Tussilago farfara** ("Coltsfoot"). The fresh bruised herb is macerated in water for 10 or 12 days, during which it turns light green and acquires the odour of pickled gherkins. The whole is then distilled. The distillate, which has a vinous odour, is saturated with common salt and re-distilled: this second distillate is shaken up with a large quantity of ether and the ether taken off and evaporated, the oil remaining behind. It is yellowish, lighter than water, very volatile, has a peculiar, strongly aromatic, penetrating odour and an aromatic taste—neither burning nor cooling. It easily takes fire and burns at first with a whitish afterwards with a reddish smoky flame. It dissolves sparingly in water; rapidly in alcohol or ether.†

Ferment oil of **Trifolium fibrini** (a species of clover). This oil is obtained from the *dried* plant. After the plant has been well boiled with water and no longer has a bitter smell, by fermentation, distillation, saturating the distillate with common salt and abstraction by ether as before described. It is pale yellow, lighter than water, smells strongly aromatic, like the ferment oil of

* Bley, N. Br. Archiv., xxvi., p. 48.

† Bley, Repert. Pharm., lxii., p. 406.

Tussilago farfara. Its taste is at first burning and sweetish, afterwards aromatic. It burns with a blue, slightly fuliginous flame, giving off strong smelling vapours which excite coughing, and leaves a small quantity of charcoal. It dissolves sparingly in water, easily in alcohol and ether.*

Ferment oil of **Urtica urens** ("The Small Nettle"), obtained as above, but from the fresh, flowering plant, which during fermentation emits first a vinous, then a sharp and intoxicating odour. It resembles the ferment oil of *Echium vulgare.*†

Ferment oil of **Vitis vinifera** (the Grape Vine). Fermented vine leaves are distilled, the distillate cohobated; the result of the second distillation abstracted with ether, and after evaporation of the ether the oil remains as usual. It is pale yellow, lighter than water, has a peculiar vinous odour *like vine-flowers and mignonette,* and a burning, sweetish, aromatic taste. It reddens litmus slightly but permanently. It evaporates in the air, diffusing a strong odour. Heated with fuming nitric acid it resinifies and assumes a grass-green colour. With sulphuric acid it forms first a white, then a light red, and ultimately a brown mixture, without losing its odour. It is not deodorised by agitation with chlorine water. With aqueous potash it forms a clear mixture from which the oil afterwards separates with red-brown colour, but with its original odour. It dissolves sparingly in water, abundantly in alcohol, ether and fixed oils. With oil of turpentine and oil of lemon it forms at first a milky solution, which afterwards becomes clear.‡

Ferment oil of Diseased Apples—"Mal oil," **Oil of Apples.** This is formed or produced by cellulostasis, a disease of the apple which imparts a *musky odour* to that fruit. It is obtained from the diseased apples by distillation with water. It is yellowish-grey, lighter than water, and boils at 109° C. Smells of musk; tastes rough and sharp. It is found on analysis to contain 64·15 per cent. C, 20·65 H, 15·15 O and 0·05 N. It volatilises completely when heated. It dissolves readily in alcohol and ether, and imparts a musk-like odour to water.§

* Bley, Jahbr. der Pharm., ii., p. 207.

† Bley, N. B. Archiv., xxx., p. 167.

‡ Bley, Rep. Pharm., lxviii., p. 301.

§ Rossignon, Journ de Pharm., xxvii., p. 158.

The fermentive principle of the leaves of plants, or so-called "plant ferment" is obtained as follows:—Select the *young* leaves and macerate them at once, or as soon after gathering them as possible in sufficient cold water to cover them; continue the maceration for 12 hours; press out the liquid, filter and add an equal volume of strong alcohol; the liquid thereupon becomes cloudy and after 12 hours yields a greyish white deposit. The liquid is then filtered, and this deposit left on the filter is the "ferment." It is to be washed with alcohol and removed from the filter for use.

The cause of the formation of these oils has not been clearly explained, but it may be due to the decomposition of certain glucosides, organic bodies of great chemical complexity, which are in some cases resolved, when left in contact with certain protein substances and water, into sugar and an essential oil. An example of a "protein substance" is *Avenin* or *Aveneine* (Series i., p. 170) which exists in the husk of oats (*Avena sativa*). To prepare it:—grind the grains with water, dilute the pasty mass with water; after 12 hours strain and filter the liquid, precipitate with acid and purify the precipitate by means of alcohol and ether.

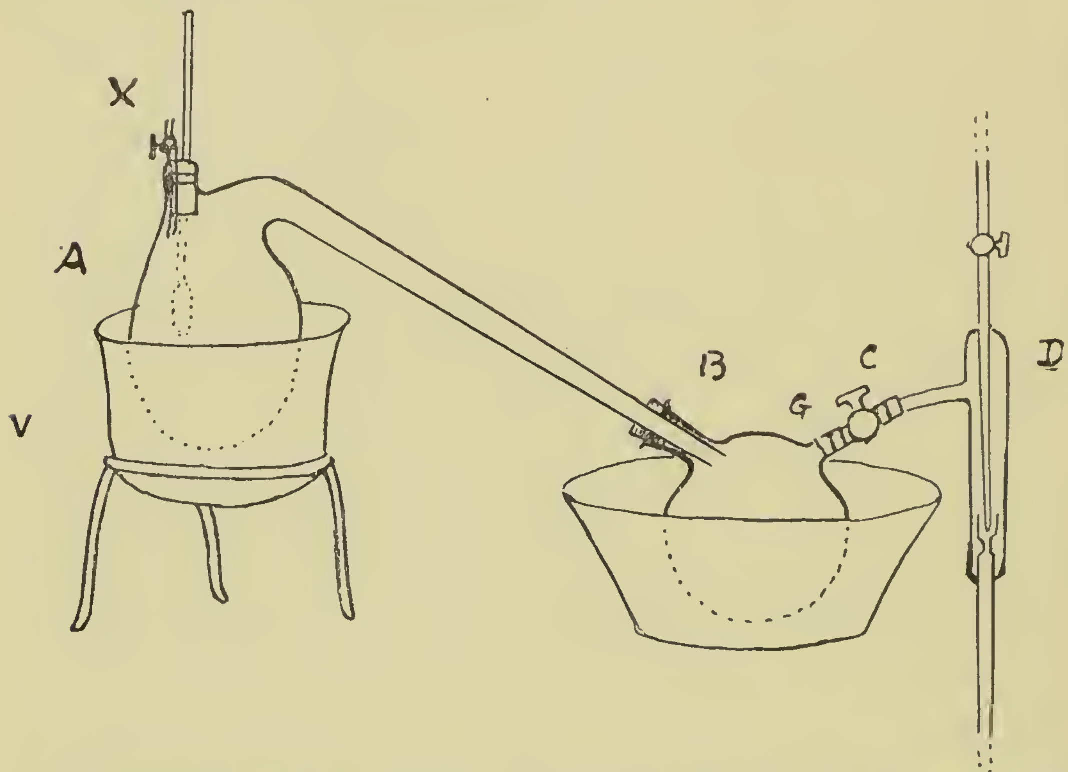
Another authority describes the preparation thus:—The grain, reduced to a state of powder or meal, is washed on a sieve, and the milky liquid, after being allowed to deposit its starch is heated to about 200° Fahr. to coagulate the albumen; when cold, acetic acid is added as long as a white powder falls, which is Avenin. This is collected on a filter, drained and dried at a gentle heat. It is a nitrogenous compound analogous to and probably identical with casein. It is greyish-white in colour, dissolves readily in water, does not coagulate by heat, dissolves also in excess of acetic and hydrochloric acids.

Gluten is a mixture of different "protein substances." It is best obtained by kneading wheat-flour under cold water until the water passes from it clear and without a milky appearance. When fresh it is greyish-white, very viscid, glutinous, elastic, tasteless, and of insipid odour.

By reason of the very volatile nature of some "ferment oils," it is necessary to evaporate off the ether or other solvent by which they have been removed from the aqueous distillate of the

fermented plant, at as low a temperature as possible, or at least by one at which the oil will not be carried over with the solvent. The tension of the vapour of these oils is not recorded, but the evaporation can be effected by one of the following methods, according to the degree of volatility of the oil. The apparatus required being in each case the same,—a difference only being made in the temperature applied to the retort and the temperature (or degree of cold) applied to the condenser.

For working on a small quantity of material the apparatus can be arranged as per sketch annexed :—



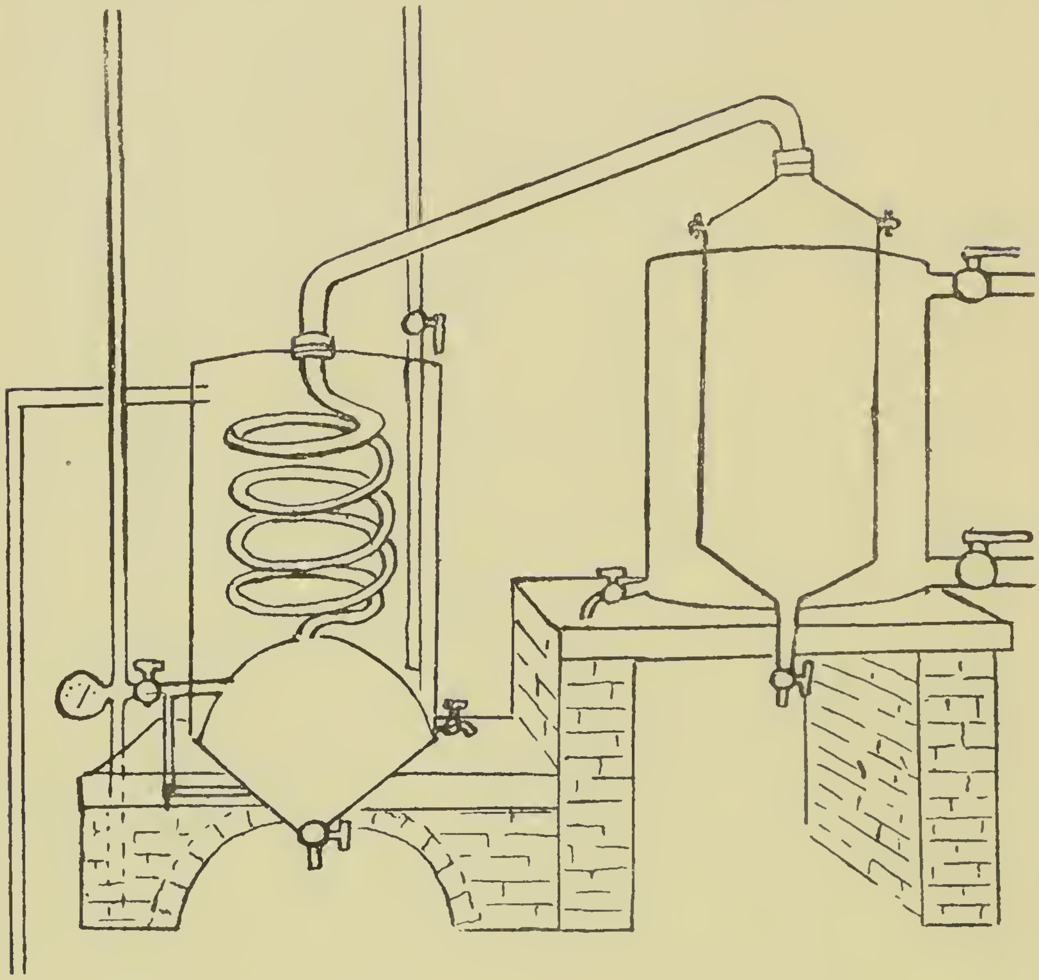
The ethereal solution of the oil contained in the aqueous distillate is put into the retort A, which is connected with the receiver B, the connection being made perfectly air-tight by a well-fitting cork covered with wax. The tube G of the receiver (also hermetically connected) is provided with a well-ground tap C, communicating with the air-pump D. When the air is exhausted by the action of the pump, the tap C is closed; the difference of temperature between the retort and the receiver (which in this arrangement is also the condenser) causes the distillation to proceed. The liquid to be distilled over is of course the ether or other solvent, and the oil resulting from the operation remains in the retort.

When the oil is not very volatile, the retort may be surrounded with water and the vessel containing it very gently warmed by a Bunsen flame beneath it; the condenser being surrounded with crushed ice. When the liquid is rather more volatile the Bunsen flame is not used, and the retort is surrounded in the vessel V with dry sand. When the oil is extremely volatile the retort is surrounded with crushed ice and the condenser is plunged into a refrigerating mixture, such as ice and salt or ice and crystallised calcium chloride. In such mixtures it is found that a greater degree of cold is produced by employing snow instead of crushed ice, by reason of the finer state of division permitting a more intimate mixture to be made. At the conclusion of the operation, the small tap X, which is carefully fitted in the cork at the neck of the retort, is very gradually opened, so as to allow air to slowly fill the vacuum. The apparatus is then disconnected, the cork at the neck of the retort taken out, and the residual oil removed.

When operating on somewhat larger quantities, the apparatus represented by the figure on page 356 is a convenient form.

The ethereal solution is placed in the still, which has a conical bottom provided with a tap for withdrawing the residuum. This vessel is enclosed in a metallic cylinder, which may be filled either with warm water supplied from a water-heater in connection with it, or with cold water, or it may be left empty, as circumstances require. The connecting pipe is connected with the body of the still and the condenser with brass unions, through which the pipes pass. The connecting pipe and worm condenser are of tin. At the base of the condenser is a dome-shaped tinned-copper vessel for receiving the condensed solvent; this part is provided with a glass "water-guage," by means of which the amount of fluid distilled over can be known. The water pump for effecting the exhaust is attached to the condenser. The operation is conducted as with the smaller apparatus above described; air being allowed to enter gently when the solvent has distilled over. The solvent is drawn off by the tap at the lower part of the condenser and the volatile oil by the tap at the lower part of the vessel corresponding to an ordinary still. Stills of this description, termed vacuum stills, are made in all sizes, and more or less modified in structure to suit different purposes and the scale on which operations

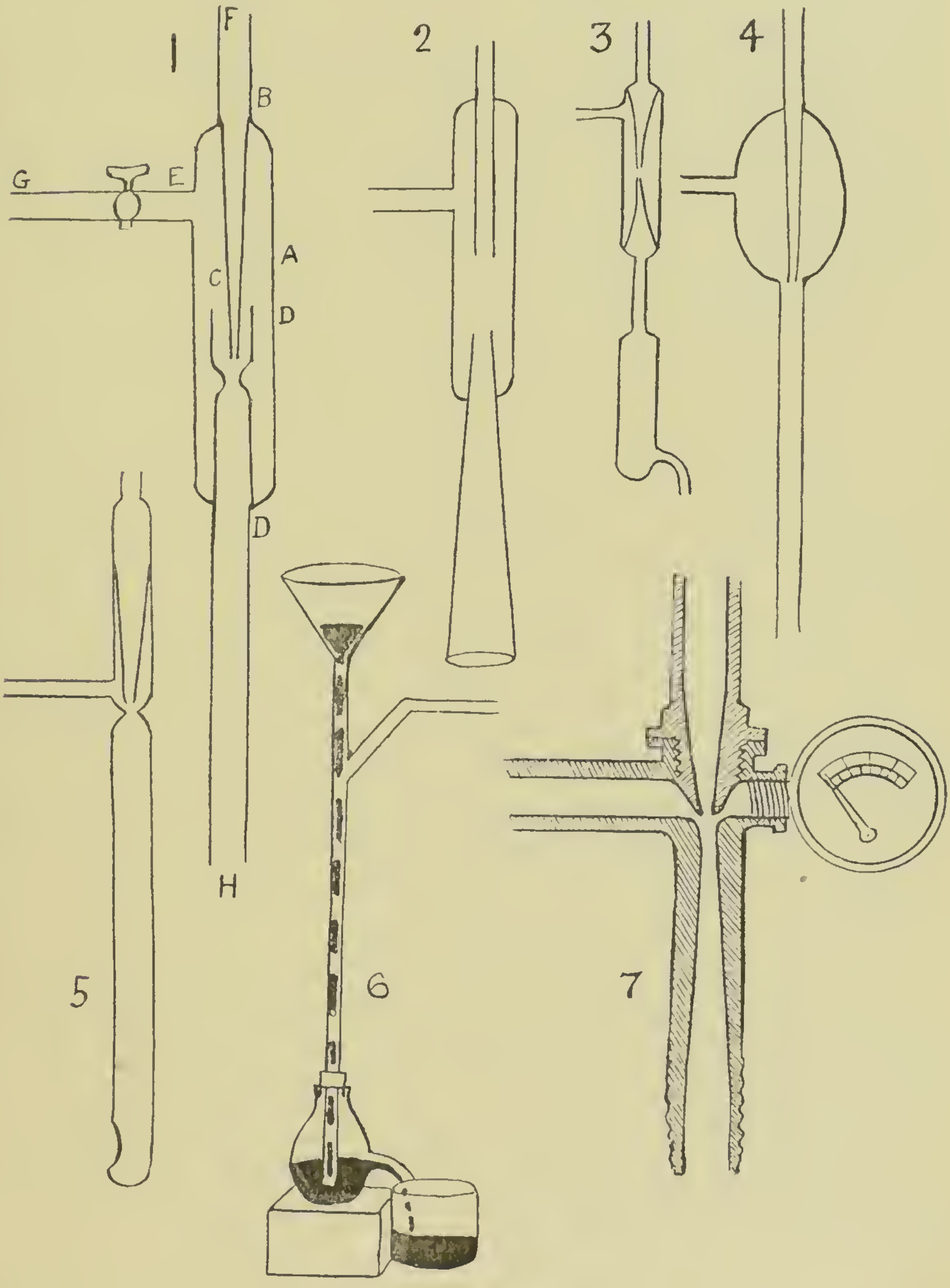
are conducted. On the large scale the vacuum is produced by an air-pump worked by steam power.*



The following are some of the forms of "aspirators," or vacuum-pumps in use for small work. In these arrangements, valves are dispensed with :—Fig. 6 is the "Sprengel": a glass tube, somewhat longer than a barometer tube, dips into a vessel containing mercury. An outlet near the top of this tube is connected to the vessel to be exhausted by means of a well-fitting piece of india-rubber tubing. The upper end of the glass tube is connected to a funnel by tubing which is provided with a clamp to enable it to be compressed if

* Such stills are made in London by J. Shears & Son and by A. Ohlson. In France they are made by Deroy, Paris-Grenelle ; Ergot, Paris ; and Berjot, Caen. These names are mentioned for the information and convenience of persons desirous of establishing business of this nature. Vacuum stills constructed on this principle are used for extracting the concrete "essences" mentioned in 1st Series, p. 63.

necessary. The funnel, supported by a ring, is filled with mercury, which runs down the tube to the lower vessel in the form of small cylinders, which are separated from one



another by spaces occupied by the air continually expanding from the vessel which is to be emptied of air. The air and mercury escape through the spout of the lower vessel. As the exhaustion proceeds, a column of mercury is supported in the vertical tube

until a maximum height is reached equal to the barometric pressure.

The pump figured No. 1 is sometimes made in glass and sometimes in brass. The tube A is about $3\frac{1}{2}$ inches long and $\frac{3}{4}$ inch diameter; into this is fitted a smaller tube, B, the upper part of which may be straight or take any convenient angle. This tube is generally narrowed to the orifice C, which is inserted about half an inch into the outlet tube D, which is also fitted into A. A connection having been made by means of tubing between the main hydrant and F, the water is forced through C, and in passing into the outlet tube it rapidly creates a vacuum, and A is rapidly exhausted, the air being drawn through the annular space at D. A tube for carrying off the affluent water may be attached to H if necessary. The inlet tube for admission of air is attached laterally, and is provided with a stop-cock, and when this is opened the air rushes into A, a continuous current being drawn through D to the outlet. In this way a stronger or weaker current of air may be produced according to the pressure of water. During the operation of exhaust, *an unvarying flow of water from the hydrant must be maintained,* otherwise there is the probability that water will be drawn back into the exhausted vessel, owing to the reduction of pressure, or rather on account of the transference of the pressure from the pump to the vessel, and for the same reason the stop-cock at E *must be turned off before* the flow of water is stopped at the hydrant. If it is desirable to have a vacuum-guage attached: it should be fitted between the stop-cock and the vessel to be exhausted.

It has been recommended to interpose a bottle between the aspirator and the condenser, in case the water should flow back from the aspirator owing to reduction of pressure from any cause. This bottle should carry a well-fitting india-rubber bung with three holes, through which pass glass tubes, one of which is connected with the aspirator, one with the condenser, and the third with a long bent glass tube (30 or more inches long), the open end of which dips into a vessel of mercury; by means of this tube the degree of exhaustion can be ascertained, for the mercury rises in the tube as the pressure decreases.

Other forms of exhaust pump very convenient for laboratary use are constructed in glass. The operation can then be watched without a vacuum gauge attached—as when the bubbles of air are not seen

rushing down the tube it is known that the maximum power of the pump is attained. Fig. 2 represents Finkener's arrangement. Fig. 3 is such as used at the London University. Fig. 4 is Geissler's. All these are supplied by Townson and Mercer, of London; also Fig. 7, Körting's "Water-Jet Vacuum Pump"; this is made entirely of metal and has a vacuum-gauge attached; with a head of 15 feet of water (a flow of 1¾ galls. per minute) it gives an almost perfect vacuum. The water supply-pipe should be as straight as possible, without any sharp bends, and be of at least ½-inch bore, to ensure the full power of this pump. The discharge pipe fixed to its lower end should end below water, by being dipped in a vessel partly filled with water, and the water-cock must be full open while working.

"Oil of Potato" is truly a ferment oil, but although of an oily nature, cannot be strictly classed as an "essential oil"; it is rather an "ethereal oil," and is closely allied to alcohol in its properties. As *fusel oil*, or crude hydrated oxide of amyl it has already been described in a foot-note to page 284. It is a component part of the spirits obtained both from corn and potatoes, and these liquors owe their peculiar smell to its presence. The greater intoxicating power of whisky (more especially that from raw unmalted grain) than other spirit, is due to the larger quantity of fusel oil which it contains. The oil is generated during the fermentation of the mash; it exists ready formed in the fermented liquids, and distils over with alcohol when a gentle heat is applied. It is observed that a greater quantity of alcohol is obtained when the mash is made quite neutral by ashes or by chalk, and that the proportion of oil in the spirit is also increased. In producing a fine-flavoured brandy from corn, the exertions of the distiller are directed as much as possible to lessen the formation of fusel oil during the fermentation of his worts, and to eliminate during the distillation and rectification of his liquors, the greatest possible proportion of that with which they may be contaminated. Considering the deleterious nature of fusel oil, it should, as far as possible, be eliminated from all spirituous beverages; when swallowed it occasions nausea, giddiness, headache, &c.: in larger quantities it causes vomiting, delirium, oppressive respiration and lessened sensibility to pain; its vapour also produces these effects. In

quantity it is a narcotic poison. The greater intoxicating effect of whisky and crude corn brandy appears to be well-known to the lower class of whisky-drinkers in this country, and the consumers of corn brandy in some of the northern parts of Europe.

Spirit made from potato starch which has been converted into sugar by dilute sulphuric acid is completely free from "potato oil."

Malt, which in the preparation of spirit, yields a fluid containing fusel oil, affords in the formation of beer, a spirituous liquor in which no trace of that oil can be detected. In brewing, the wort is certainly not allowed to ferment to the full extent, from one-half to three-fourths only of the sugar being converted into alcohol, but the addition of the hops modifies the transformations which take place. It is known that volatile oil of mustard and the empyreumatic oils, arrest completely the action of yeast; and, although the oil of hops does not possess this property, it still diminishes in a great degree the influence of decomposing nitrogenous bodies on the liquid with which they are in contact, and modifies the nature of the products generated.

According to the recent researches of Perdrix,* the fusel oil found in commercially prepared alcohol is formed by the action of bacteria. He avers having separated from Paris water a bacillus, *B. amylozymicus*, which ferments starch with production of amyl alcohol. It is separated by cultivation on potatoes, and finally on gelatin. To those who are interested in the theory of fermentation, this paper is particularly recommended.

Early researches of great interest "On the phenomena of Fermentation" were made known by Fownes†: results of more recent and searching investigations by Pasteur, on this important subject, have also been published, and are of great interest.‡

* Journ. Chem. Soc., Jan., 1892.

† Pharm. Journ. [i.], 1842, a series of articles.

‡ Etude sur la bière, ses maladies, causes qui les provoquent. Procédé pour la rendre inaltérable, avec une nouvelle théorie de la fermentation, par M. L. Pasteur, Chez Gaultier-Villars, Paris. Refer also to Le Moniteur Scientifique Quesneville, xviii., pp. 993-1012, "Quelques observations au sujet du dernier ouvrage de M. Pasteur; sur la fermentation et la fabrication de la Bière, par Ch. Blondeau. An elaborate paper by Dr. Max Mærcker, on the manufacture of alcohol (theoretical and practical), and a paper on alcoholic derivatives by Dr. Bannow, is to be found in the Moniteur Scientifique, xix., pp. 995-1038.

A paper on the composition of *Grape spirit* and Wine Brandy, by Ch. Ordonneau, was read at the meeting of the French Academy of Sciences, 25th Jan., 1886,* being presented by Pasteur. The author of that paper remarks that the production of Grape spirit having diminshed, in consequence of the ravages of the phylloxera, more attention has been paid to the production of pure grain spirit, and that recent improvements in distillatory apparatus have resulted in the production of a nearly pure " alcool neutre " (silent spirit); but yet, such alcohol still possesses a peculiar odour, recognisable by professional tasters, and known by the name of " odeur de trois-six," and which is absent in the alcohol of wine. In his memoir, Ordonneau says :—" I searched for the cause of this difference, and made a comparative study of Old Cognac brandy and ordinary commercial spirit. I submitted to fractional distillation in an apparatus very similar to the Henninger-Claudon, 3 hectolitres of Cognac brandy, 25 years old and of undoubted purity. The most volatile portions contained aldehyde, acetic ether, acetal, and traces of propionic and butyric ethers. The least volatile portion, after being rectified several times, yielded about 1,200 grams. of a product possessing the particular odour of the brandy under investigation. As a result of the fractionations I was able to identify the presence of the bodies contained in this Cognac, as per table annexed :—

Acetic aldehyde	3	grams. per hectolitre
Acetic ether	35	„ „
Acetal	35	„ „
Propylic alcohol, normal	40	„ „
Butylic alcohol, normal	218·60	„ „
Amylic alcohol	83·80	„ „
Hexylic alcohol	0·60	„ „
Heptylic alcohol	1·50	„ „
Propionic, Butyric & Caproic ethers	3	„ „
Œnanthic ether, about	4	„ „
Bases, amines	4	„ „

The important feature in this analysis is the determination of so large an amount as 218·60 grams. per hectolitre of normal butylic alcohol, boiling at 116°-118° C. It is also notable that the pure amyl alcohol, the regular presence of which in wines has

* Comptes Rendus, cii., p. 217.

been ascertained by Henninger, does not appear to cause any unpleasant flavour in brandy when existing to the extent above recorded and in association with the other flavouring constituents. On examining, for comparison, the commercial brandies (from maize, beetroot and potato), I have found propyl alcohol, amyl alcohol (active and inactive), pyridine, a compound boiling between 180°-200° C. (collidine?), and isobutyl alcohol, but no trace of normal butyl alcohol."

"The presence of normal butyl alcohol in brandy leads me to suppose that it is the usual product of alcoholic fermentation when elliptical yeast is the fermentive agent, and that isobutyl alcohol is formed when fermentation is developed by beer yeast. To test this theory I fermented 100 kilos of sugar molasses with wine lees which had been dried in the air, and from the resulting 19 litres of alcohol of 92° I extracted an oil of agreeable odour, very different from that extracted from the commercial oil of the distilleries and containing normal butyl alcohol mixed with amyl alcohol. This oil resembles that which is distilled from new wine. This experiment proves therefore, that elliptical yeast generates secondary products different to those produced by beer yeast. The odour which merchants call the odour of "trois-six" observable in ordinary commercial brandy, is due to the presence of isobutyl alcohol, which the process of rectification, as carried out at the distilleries, cannot remove. Isobutyl alcohol also has an unpleasant taste, while the normal butyl alcohol possesses the fine *recherchée* flavour so much admired by judges of brandy."

The memoire by Ordonneau in the "Comptes Rendus" above referred to, concludes by stating that all saccharine solutions fermented with elliptical yeast will yield alcohols of good flavour and odour. This yeast is as easily cultivated as beer yeast. It is technically known as a "bottom yeast." It acts vigorously at 28°-32° C., and does not appear to degenerate after many cultivations. Its appearance under the microscope is delineated in Pasteur's work "On Fermentation."

Experiments have been made to determine whether this elliptical yeast (*saccharomyces ellipsoideus*) is merely a form of beer yeast determined by the influence of a special medium, the must of grapes, and if so, whether it could be induced to return to its primitive form. The experiments consisted in sowing the ferment in different media, among others in an unmalted barley-wort to

which acid tartrate of potassium had been added to prevent lactic fermentation, and to approximate the liquid in composition to grape must. No evidence was obtained in any case of the modification of the ferment, but it was observed that in the unmalted barley-wort the fermentation was quite different from that taking place in the formation of beer and that the fermented liquor had the character of a *true barley wine.* This barley wine is described* as being an agreeable beverage, giving upon analysis results that point to it being more nourishing than grape wine, also by using a large proportion of the cereal and the addition of saccharose to the wort it has been produced containing 8 to 10 per cent. of alcohol.

Butyl alcohol, $C_4H_{10}O$, or *Tetryl alcohol* of Wurtz,† was for a long time the only butyl alcohol known to chemists. It has been described as best prepared by subjecting the fusel oil obtained in the rectification of mangold-wurzel molasses to fractional distillation; the portions which distil over between 80° and 105°, 105° and 115°, and 115° and 125°, being collected apart. The first portion is washed with water, and the separated oily layers repeatedly rectified; the portion which passes over at 104° being each time collected apart. The latter is mixed with the portion which distilled over between 105° and 115°, and with that part of the last fraction (between 115° and 125°) which, when the latter was repeatedly rectified, passed over below 115°. The whole of the distillates obtained between 105° and 115° are then mixed together and boiled for 48 hours with a concentrated solution of caustic potash in a vessel connected with a reflux condenser. The impure tetrylic alcohol is then distilled over, separated from the water which passed over with it, afterwards mixed with half its weight of quick-lime to dehydrate it more completely, and distilled off after standing for 24 hours: this distillate is repeatedly rectified, and the portion which passes over between 108° and 110° is collected apart. If the boiling point remains within these limits during the distillation, the tetrylic alcohol thus obtained is nearly pure. The process of rectification may be considerably abridged by interposing between the flask and the condensing apparatus, an upright tube with two bulbs and

* Comptes Rendus, cvi., p. 644.

† Comptes Rendus, xxxv., p. 310.

having a thermometer inserted into its upper part; the less volatile portions then condense on the sides of the tube and run back into the flask, whereby the separation of the more volatile portions is greatly facilitated.

Thus prepared, it is a transparent colourless liquid, more mobile than amylic alcohol, and having an odour somewhat similar to that of the latter, but more vinous. It is inactive to polarised light. Its sp. gr. is 0·8032 at 18·5; boiling point, 110° C. It dissolves in $1\frac{1}{2}$ times its weight of water at 18° C., and is precipitated therefrom as an oily layer on addition of chloride of calcium, chloride of sodium or any other easily soluble salt. It is converted by caustic potash in a state of fusion into butyric acid, with evolution of hydrogen and formation of a hydrate.

It has since been shown that this common butyl alcohol gives iso-butyric acid by oxidation with dilute chromic acid, it is therefore considered to be an iso-alcohol. It is contained in *Isopropyl carbinol* (*Iso-primary butyl alcohol*), which has been thoroughly examined by Chapman and Smith.* Its boiling point is 109° C., being sensibly lower than that of the normal alcohol. Its sp. gr. is 0·8055 at 16·8. It dissolves 1 atom of sodium, but slowly, and only on brisk agitation and warming; but calcium chloride, potassium acetate and potassium hydrate are dissolved by it with facility. It mixes easily with glacial acetic acid and with the same acid diluted with twice its bulk of water.

In Watts' Dictionary of Chemistry, 1st supp., p. 372, it is stated, in reference to the butyl alcohols:—"There are two varieties of primary butyl alcohol, viz., Propyl-carbinol and Isopropyl-carbinol. Propyl-carbinol, or *Normal primary butyl alcohol*, is comparatively little known, and has not hitherto been found as a natural product."† It was obtained synthetically by Schöyen‡ from ethyl gas by submitting it to the action of chlorine and subsequent conversion of the resulting alcohol. A much more complete investigation of the compound was published by Lieben and Rossi.§ These chemists first prepared butyric aldehyde by treating a mixture of butyrate and formate of calcium. From the

* Journ. Chem. Soc. [2], vii., p. 155.

† This paragraph was, of course, written before Ordonneau's paper in the Comptes Rendus above quoted, was published.

‡ Ann. Chem. Pharm., cxxx., p. 235.

§ Comptes Rendus, lxviii., p. 1561, et seq.

aldehyde the alcohol was obtained by dehydrogenation with sodium amalgam. The alcohol, when properly dried, boils at 115° C. It is considerably lighter than water, in which it is very sparingly soluble.

The odorous compound Isobutylbenzene is mentioned in series i., p. 240, and the Methyl-isobutylbenzene (a musk substitute) at p. 8 of the same. They will be referred to in this volume.

The substances in wine to which its taste and bouquet are due are generated *during the fermentation* of the juice of such grapes as contain a certain quantity of tartaric acid; they are not found in wines free from all acid, or which contain a different organic acid, such as acetic acid.

The wines of hot climates possess no odour; wines grown in France possess it in a marked degree, but in the wines from the Rhine districts the perfume is most intense. The kinds of grapes on the Rhine, which ripen very late and scarcely ever completely, such as the Riessling and Orleans, have the strongest perfume or bouquet, and contain proportionately, a larger quantity of tartaric acid. The wines from the earlier grapes, such as the Rulander and others, contain a large proportion of alcohol, and are similar to Spanish wines in their flavour, but they possess no bouquet.

The grapes grown at the Cape of Good Hope from Riesslings, transplanted from the Rhine, produce an excellent wine, but it does not possess the aroma peculiar to Rhenish wine.

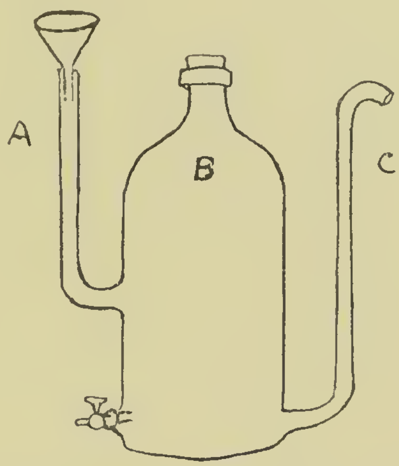
It is evident from these facts, that the acid of wines, and their characteristic perfumes, have some connection, for they are always found together, and it can scarcely be doubted that the presence of the former exercises a certain influence in the formation of the latter. This influence is very plainly observed in the fermentation of liquids destitute of tartaric acid, and particularly of those which are nearly neutral or are alkaline, such as the mash of potatoes or corn.

The juice of grapes grown in different climates differs not only in its proportion of free acid, but also in respect of the quantity of sugar dissolved in it. The quantity of nitrogenised matter in the juice seems to be the same in whatever part the grapes may grow; at least, no difference has been observed in the amount of yeast formed during fermentation in the south of France and on the Rhine.

Liebig observed that grapes grown in hot climates and the boiled juice obtained from them, are proportionately rich in sugar. Hence, during the fermentation of the juice, the complete decomposition of its nitrogenised matters, and their separation in the insoluble state, are effected before all the sugar has been converted into alcohol and carbonic acid. A certain quantity of the sugar consequently remains mixed with the wine in an undecomposed state, the condition necessary for its further development being absent. The nitrogenous matters in the juice of grapes of the temperate zones, on the contrary, are not completely separated in the unsoluble state when the entire transformation of the sugar is effected. The wine of these grapes, therefore, does not contain sugar, but variable quantities of undecomposed gluten in solution. This gluten gives the wine the property of becoming spontaneously converted into vinegar when the access of air is not prevented; for it absorbs oxygen and becomes insoluble, and its oxidation is communicated to the alcohol, which is converted into acetic acid. By allowing the wine to remain at rest in casks with a very limited access of air, and at the lowest possible temperature, the oxidation of this nitrogenous matter is effected without the alcohol undergoing the same change, a higher temperature being necessary to enable alcohol to combine with oxygen. As long as the wine in the "stilling casks" deposits yeast, it can still be caused to ferment by the addition of sugar, but old, well-cleared wine has lost this property, because the condition necessary for fermentation, viz., a substance in the act of decomposition or putrefaction, is no longer present in it. In hotels and other places where wine containing much gluten is drawn gradually from a cask, and a proportional quantity of air necessarily introduced, its eremacausis (conversion into acetic acid), is prevented by the addition of a small quantity of sulphuric acid. This acid, by entering into combination with the oxygen of the air contained in the cask or dissolved in the wine, prevents the oxidation of the organic matter.

"**Cognac Essence**," "*Oil of Cognac*," or commercial Œnanthic ether. This article is produced on a large scale by distilling wine-lees, either dried and pressed into cakes, or in their wet state, mixed with 7 or 8 times their weight of water; the distillation being effected by passing a current of dry steam through the mix-

ture. It is prepared in quantity from the residue left in the stills. after the distillation of grape-brandy. In distilling this residue, a small quantity of residual alcoholic hydrate distils over at the same time; this is separated from the ether by being received in a Florentine flask, or an apparatus effecting the same purpose, but constructed to prevent loss by evaporation, as shewn in the annexed illustration:—



The condensed liquid flows into the funnel-shaped end of the tube at A, and from there into the flask B, which has previously been filled completely with water, which takes up the alcohol, and causes the compound organic ether, mixed with some alcohol, to rise to the top. The alcoholic hydrate becomes opaque, owing to the separation of the ether. The tube C carries off the excess of the alcoholic liquid below. The cooler the condensed liquid is, the more complete is the separation. The ether is drawn off by a pipette and then neutralized by agitation with a weak solution of carbonate of potash, freed from water by a few fragments of chloride of calcium and then re-distilled. It then appears as a mobile, colourless, or slightly yellow liquid, of almost overpowering or stupefying wine-odour. Its intoxicating vinous odour has been compared to that of an empty wine-cask. It is lighter than water, and boils at about 500° Fahr. It is very sparingly soluble in water, but freely soluble in alcohol. Its sp. gr. is about 0·862. It is not pure Œnanthic ether but a very complex body, containing many other ethers, according to the nature of the wine it is derived from, and according to slight variations in process of manufacture. This, and other oils of this nature, should be kept dissolved in alcohol, in order that the full flavour be retained. It is used for

flavouring common corn brandy and for making imitations of wines, also in the preparation of certain artificial fruit essences. The oils distilled from the lees of Rhenish and Moselle wines are preferred. Inferior qualities of cognac-oil are of greenish-brown colour and are somewhat viscous. Brandy from any part of the world may be very closely imitated by distilling the oil from the lees of the wines produced in that particular district. It was ascertained by Winckler* that the specific odorous principle peculiar to the various sorts of wine produced in different countries or districts, which is known by the expression of *blume* or *bouquet*, can be extracted in the following way: "If about half a pint of any sort of grape-wine be evaporated in a porcelain vessel by means of steam, until not only all the alcohol but also the Œnanthic ether and all the constituents volatile at 100° C (212° Fahr.) are evaporated, a thickish liquid of more or less dark colour, and of a peculiar, pleasant, acidulo-vinous odour remains behind, from which, on cooling, a greater or lesser quantity of tartar separates. By diluting this liquid with water so that the weight of the solution is about a quarter of a pound, and subjecting the solution with an equal weight of fresh-burnt lime, to distillation, there is obtained, even during the slaking or hydrating of the lime, a very agreeably and intensely odorous distillate which is a nitrogenous base, and possesses in a high degree the "bouquet" of the original wine. This liquid forms with acids neutral salts which possess the same odour. If the residuary lime of the evaporated wine be treated with water after the conclusion of the distillation, the solution filtered and the filtrate distilled with a small quantity of moderately strong sulphuric acid, a new volatile acid of a highly specific, almost balsamic, odour is obtained, which, being neutralised by the necessary quantity of the nitrogenous base above-mentioned, yields a neutral volatile salt which possesses in the highest degree the peculiar bouquet of the wine employed." Winckler's paper concludes by mentioning that the results of the experiment were confirmed on operations upon six different sorts of red and white wines.

An opinion as to the formation of the "bouquet" of wines was given by Stracke in the Journal de Pharmacie, 1862. He says it is due, not to the intervention of tartaric acid as some have

* Jahrbuch f. Prakt. Pharm. Bd., xxv., Hft. i., p. 7.

thought, but to the decomposition of the oil contained in the pips of the grape under the influence of fermentation, and that the veritable "bouquet" may be obtained by fermenting pure sugar with washed yeast, to which has been added an emulsion prepared with the pips of the grape. This theory is rather remote.

All the above-mentioned products are totally distinct from the compound intended to be known as "**Heavy oil of wine**" by pharmacists; an exact scientific definition of which yet appears to be wanting. The subject is of sufficient importance to have attracted the attention of Professor Frederick B. Power, a very eminent authority on organic chemistry, especially the chemistry of ethereal oils. He has most exhaustively reviewed the facts published concerning this compound, in a paper in the "Pharmaceutische Rundschau," November, 1891, and yet asks "What is heavy oil of wine?" (referring to the *Oleum æthereum* of the Pharmacopœia). The inference is—that a standard of the identity and purity of this official compound is not established. On refering to "Gmelin's Handbook of Chemistry," xiii., p. 177, we find that *heavy oil of wine* or the so-called *sulphovinate of wine oil* as distinguished from the *light oil of wine*, was discovered by Hennel in 1826, and that it is obtained in the following manner:—"It passes over in the preparation of ether, towards the end of the distillation. It is formed, but in exceedingly small quantities, not only on distilling, but immediately on mixing alcohol with sulphuric acid (Marchand). It is also produced when ether is acted upon by anhydrous sulphuric acid (Liebig), and by the dry distillation of the sulphovinates." With regard to the method for its preparation, the following is further recorded:—1°—When 1 part of alcohol is distilled with $2\frac{1}{2}$ parts of sulphuric acid, a little ether passes over first, then a yellowish oil and an aqueous ethereal liquid; the former is separated from the latter, and freed from uncombined sulphuric acid and a part of the sulphurous acid, the alcohol and the ether, by agitation with water (which, according to Liebig, should be ice-cold). The oil is then separated from the water, and placed over sulphuric acid, under the receiver of an air-pump, which is slowly exhausted in order that the evaporation of the ether and sulphurous acid may not cause the liquid to boil violently (Serullas). 2°—Crystallised sulphovinate of lime is dried carefully and completely in vacuo,

and submitted to dry distillation. The distillate is purified as in the first method (Serullas)."

Fehling's "Neues Handwörterbuch der Chemie" band i., p. 100, also contains a notice of heavy oil of wine, as follows:—*Ethyl-sulphate of Etherol; Sulphate of Etherin,* "Heavy oil of wine or Sulphovinate of wine oil." Perhaps only a mixture of hydrocarbons with ethyl sulphate. Its formula is possibly $(C_8 H_{18} S_2 O_7)_n$. Examined by Hennel, Serullas, Marchand, and Liebig. It is produced in the manufacture of ether, towards the end of the process, when sulphurous acid and ethylene are also formed; furthermore, by the dry distillation of salts of ethyl sulphuric acid, especially the basic lead salt alone, or the potassium salt with freshly burned lime. The substance, purified by washing with water and drying in a vacuum over sulphuric acid, is a colourless viscid oil, having an aromatic odour and a cooling taste. Its sp. gr. is 1·135. At a high temperature it volatilises without decomposition and is readily soluble in alcohol and in ether. Potassium decomposes it only on heating. When heated with water it is decomposed into a light oil, *etherol,* and ethyl-sulphuric acid (possibly also isaethionic acid).

"**Etherol,** *oil of wine,* Light or Sweet oil of wine, $C_n H_{2n}$, consists, after the so-called *etherin* has been separated in a crystalline form by cold, of a yellowish, thick oil. Its sp. gr. is 0·921, boiling point 280° C. and it crystallises at —25° C. It is readily soluble in ether, less soluble in alcohol, and insoluble in water. With sulphuric anhydride it appears to afford isaethionic acid. Whether the so-called 'Sweet, or Light oil of wine' which is produced by the manufacture of ether on a large scale, is identical with etherol, can scarcely be stated with certainty."

In Watts' Dictionary of Chemistry, ii., p. 507, the following notice of this subject occurs:—"When heavy oil of wine, the body which sometimes occurs among the residues of the preparation of ether, is warmed with water, a light oily liquid rises to the surface, which is a mixture of two substances, both polymeric with ethylene, viz., *etherin* and *etherol.* On decanting this liquid and leaving it at rest, the etherin crystallises out while the etherol remains liquid. The etherin may be freed from etherol by filtration and pressure between paper, and crystallised from alcohol or ether. *Etherin* forms transparent, colourless, shining prisms,

moderately hard, very friable, and grating between the teeth; it has no taste, but when heated smells like etherol. Melts at 110° C. Boils at 260° C. without alteration. Insoluble in water, but soluble in alcohol, and still more so in ether. *Etherol* is a yellowish, viscid liquid of sp. gr. 0·921 (Serullas), boiling at 280° C. By exposure to cold it becomes more viscid, but does not solidify even at —35° C. It has a peculiar, aromatic odour, is insoluble in water, but dissolves easily in ether, less easily in alcohol. Potassium immersed in it retains its lustre undiminished. *Heavy oil of wine*, which passes over in the preparation of ether towards the end of the distillation, when sulphurous anhydride and olefiant gas are given off, is, according to Liebig, an *ethyl-sulphate of etherol.* On treating it with water, the etherol (holding the isomeric body, etherin, in solution) separates out, and ethyl-sulphuric acid remains in solution. An oil of similar character and composition is obtained by the distillation of perfectly dry ethyl sulphates, the best process, according to Liebig, being to distil the dry potassium salt with an equal weight of freshly-burned lime. Marchand recommends the distillation of dry ethyl sulphate of lead. The crude product is freed from alcohol, ether and sulphurous acid by agitation with cold water and drying in vacuo over sulphuric acid."

In Hirsch's Universal Pharmacopœia, band ii., p. 273, it is stated that "the so-called heavy oil of wine, of which one half of the preparation *(oleum æthereum)* consists, is to be regarded as a solution of solid etherin and liquid etherol (both of the empirical formula $C_2 H_4$) in sulphurous ether (ethyl sulphite), $(C_2 H_5)_2 O_3$ and sulphuric ether (ethyl sulphate), $(C_2 H_5)_2 S O_4$ in proportions which have not been more accurately determined, and which are also probably very variable."

Schmidt, in his Pharmac. Chemie., band ii., pp. 201 and 202, states in connection with ether, that "if in the manufacture of the latter the supply of alcohol is deficient, or the temperature during the process rises above 145° C., or if finally the sulphuric acid becomes too hydrated, there is formed, besides sulphurous and carbonic anhydrides, ethylene, which through polymerization becomes partly converted into solid etherin (melting point 110° C.; boiling point 260° C.) and into liquid etherol, both of the formula $(C_2 H_4)_n$. Besides the latter bodies, there also pass over in the manufacture of ether small amounts of ethyl-sulphite

$(C_2 H_5)_2 SO_3$, and ethyl-sulphate $(C_2 H_5)_2 SO_4$. A mixture of the latter ethers with etherin and etherol was formerly designated as 'heavy oil of wine.'"

The authors of the National Dispensatory, iii. edit., p. 1043, in connection with the subject of *oleum æthereum*, state, regarding the composition of heavy oil of wine, as follows:—"The analyses of Serullas, Liebig and others lead to the empirical formula $C_8 H_{18} S_2 O_7$. Serullas regarded heavy oil of wine as the double sulphate of ethyl and ethylene; Liebig as ethyl-sulphate (sulphovinate) of etherol. The latter view appears to be the more correct if the decomposition with water is taken into consideration. Alkalies also decompose it into sulphovinate of the alkali, liberating etherol. Or it may be related to sulphuric ether or ethyl-sulphate discovered by Wetherill (1848), which is a yellowish oil of the sp. gr. 1·120, has a peppermint-like odour and pungent taste, and the composition of which is expressed by the formula $(C_2 H_5)_2 SO_4$. Sulphurous ether or ethyl-sulphite, $(C_2 H_5)_2$, which was discovered by Ebelmen (1845), has the sp. gr. 1·17 at 0°, boils at 208° C., and is decomposed by potassa into potassium-sulphite and alcohol. In 1881, Hartwig examined the oily liquid which may be obtained by distilling the acid residue left in the distillation of ether.* This oil has been sold as oil of wine, but is totally different from both the heavy and light oils of wine mentioned above, and consists of hydrocarbons, ethers and ketones, among them ethyl-amyl ether, $C_2 H_5—C_2 H_{11} O$, which boils at 112° C.; di-isoamylene, $C_{10} H_{20}$, boiling at 157° C.; ethyl-amyl ketone, $C_2 H_5—C_5 H_{11} CO$, boiling near 155° C.; methyl-hexyl ketone, and several others having a higher boiling point." In the United States Dispensatory the chemistry of this subject is also briefly reviewed, but without affording any further information than that which has been presented in the preceding notices.

A concise but very comprehensive view of this subject is given by Roscoe and Schorlemmer in their "Treatise on Chemistry," iii., pt. i., pp. 353-355. In connection with the normal ethyl-sulphate these authors present the following information:—"*Normal ethyl sulphate*, $(C_2 H_5)_2 SO_4$. This compound was examined by chemists in the last century, but its nature has only quite recently been ascertained. Formerly this ether was prepared by distilling

* Journ. f. Prakt. Chem., No. 10, 1881; and Chemical News, 1881, p. 122.

spirit of wine with oil of vitriol. This operation was conducted in a retort heated in a sand-bath, and as soon as the ordinary ether had come over, the receiver was changed, and normal ethyl-sulphate, or as it was termed "wine oil" or *oleum vitrolii dulce*, collected. Concerning the formation and composition of this body, very different views were held. Towards the end of the last century it was generally assumed that wine oil is ether rendered impure by the presence of a large quantity of sulphuric acid, for Wiegleb stated that common ether is obtained in large quantities when this substance is distilled with caustic potash. In the year 1797 the difference between wine oil and common ether was distinctly pointed out by Fourcroy and Vauquelin, who assumed that the first compound stood in the same relation to ether as ether does to alcohol. This view was generally adopted, until Hennel, in 1826, proved that the compound contains sulphuric acid, and that it is to be considered as a compound of this acid with carbon and hydrogen, in which the latter elements are present in the same relative quantities as in ether itself. He also showed that when wine oil is heated with water or with alkalies, sulphovinic acid is formed, whilst a liquid hydrocarbon is liberated. This in some cases crystallises, and possesses the composition of olefiant gas. These facts were fully confirmed by the subsequent investigation of Serullas,* Marchand† and Liebig.‡ Serullas found that when wine undergoes distillation, it yields the salts of ethyl-sulphuric acid, and Liebig gave to it the formula $(C_2 H_5) S O_4 + C_4 H_8 S O_3$ and termed it sulphovinate of wine oil. According to the recent experiments of Claesson,§ wine oil consists chiefly of ethyl-sulphate, generally mixed with a larger or smaller quantity of the polymers of ethylene, a fact already observed by Hennel, this latter chemist distinguishing between wine oil, a liquid boiling at 280° C. and etherin, a solid crystalline mass obtained when the wine oil is allowed to stand for some days. The first attempt to obtain pure normal ethyl-sulphate was made by Wetherill,|| who passed the vapour of sulphur trioxide into

* Ann. Chem. Phys., xxxix., p. 153.

† Journ. Pract. Chem., xv., p. 8.

‡ Pogg. Ann., xxi., p. 40.

§ Journ. Pract. Chem. [2], xix., p. 255.

|| Ann. Chem. Pharm., lxvi., p. 117.

ether or alcohol. He thus obtained a colourless liquid smelling like peppermint, which decomposes on heating, and which, as Erlenmeyer afterwards showed, is a mixture of normal ethyl-sulphate and ethyl-isothionate,

$$C_2H_4\begin{cases} O\,H \\ S\,O_3\,C_2\,H_5. \end{cases}$$

Ethyl sulphate was first obtained in a pure state by Claesson in acting on alcohol with ethyl chlorsulphonate, $Cl—S\,O_2—O\,C_2\,H_5$. He also prepared it by the action of sulphuric acid on absolute alcohol. If ice and then water be added to the cold mixture, and the liquid shaken up with chloroform, the sulphate is dissolved and left behind on evaporation. Ethyl sulphate is also formed when silver sulphate is heated with ethyl iodide to 150° C.* Claesson obtained a satisfactory yield in this way. He says, "Ethyl-sulphate is a colourless liquid, insoluble in water, possessing a pleasant peppermint-like smell. It boils at 208° C. with slight decomposition, but may be distilled unaltered under diminished pressure. At 19° C. it possesses a sp. gr. of 1·1837. It is only very slowly decomposed by cold water, but boiling water decomposes it more or less quickly according to the amount present, alcohol and ethyl-sulphuric acid being first formed."

The U.S. Pharmacopœia, 1880, indicates the proportions of alcohol and sulphuric acid in the process of preparing *oleum æthereum* to be as follows :—24 parts by weight of alcohol, sp. gr. 0·820 (=26·26 by volume) and 54 parts by weight of sulphuric acid, sp. gr. 1·840 (=29·34 parts by volume). These are the same as those adopted by Dr. Squibb many years ago as a result of quite an elaborate series of experiments : they are also the same proportions used by Prof. Diehl.‡ In an experiment made by Prof. Power, 500 c. c. of official alcohol and 500 c. c. of chemically pure sulphuric acid were mixed, allowed to stand for 24 hours, and then subjected to distillation in a flask of such capacity as to be nearly filled by the liquid, and which was provided with a good condenser. To the receiver a glass tube bent at right angles was attached, in order to conduct the liberated and uncondensed gases into water for their absorption. The first drops of distillate came over at

* Ber. Deutsch. Chem. Ges., xi., p. 514.

† Am. Journ. Pharm., 1857, pp. 192-204, and 1861, pp. 57-61.

‡ Ibid, 1865, p. 104, and Proc. Am. Pharm. Assoc., pp. 309-316. See also papers by Prof. Maisch, Am. Journ. Pharm., 1865, pp. 100-105.

147° C. (barometric pressure 735 m. m.), but the mercury soon rose to 150° C., and the distillation was conducted between 150° and 160° C. After about four hours, the liquid in the flask became quite thick and was thoroughly carbonised. As no more liquid distilled over at the above-mentioned temperature, and a strong current of sulphur dioxide was evolved, owing to the reduction of the sulphuric acid by the carbonaceous matter, the operation was discontinued. The ethereal distillate was treated as directed in the official process, when 2·5 grams of pure heavy oil of wine, or 0·597 per cent. of the weight of alcohol employed was obtained. This is somewhat less than Dr. Squibb has stated to have obtained in working upon a larger scale, for in a series of distillations with a total use of 1664 pounds of sulphuric acid, and 686 pounds of alcohol, he obtained 97 avoirdupois ounces of finished oil, or 0·884 per cent. of the weight of alcohol employed.* The yield obtained by Prof. Diehl, in the U.S. Army Laboratory seems to have been considerably higher (about 1·4 to 1·9 per cent.) although he employed the same proportions of alcohol and acid (equal parts by volume) as are directed in the U.S. official formula.†

In the process of the British Pharmacopœia, it is evidently assumed that the yield of heavy oil of wine shall be about 1 per cent. by volume, at least, of the alcohol consumed, for 3 fluid drachms of the oil are directed to be used, and this is to be obtained from 40 fluid ounces, or 320 fluid drachms of rectified spirit. The yield stated by Dr. Squibb of 0·884 per cent. by weight, corresponds to 0·684 per cent. of the alcohol by volume. Dr. Power states, in his paper above referred to, that, after reviewing the existing knowledge of so-called heavy oil of wine, "it is clearly evident that the *oleum æthereum* of the Pharmacopœia is an exceedingly unsatisfactory preparation, not only with consideration of its small yield, but more especially on account of its indefinite and probably variable chemical character, and the complete lack of information as to which of its constituents represents its assumed medicinal virtues." Also,—"it has been shown that the heavy oil of wine or ethereal oil of commerce, is, for the most part, a by-product in the manufacture of ether, and is a liquid of entirely different chemical composition from that produced by the process of our

* Am. Journ. Pharm., 1861, p. 60.

† Ibid, 1865, pp. 100 and 126.

Pharmacopœia, consisting, as previously mentioned, of a complex mixture of hydrocarbons, mixed ethers and ketones. Of these bodies, probably not a single one has been studied with regard to its physiological action in a pure and isolated condition."

SECTION III.

Empyreumatic Oils and Aromatic Products of Destructive Distillation.

Destructive distillation is a very ancient industry, whose intricate and numerous problems have been from time to time investigated by the ablest chemists. In the sixteenth and seventeenth centuries it came to be the principal work in chemical laboratories.

Destructive distillation is the decomposition by heat of a substance in a closed vessel, in such a manner as to obtain liquid products.

By a *product* is meant a body not originally present in the substance distilled. A body merely extracted without change by distillation is termed an *educt*.

As stated by Dr. Mills in his very useful Manual,* "the nature of the products depends,—1st, on the composition of the substance heated; 2nd, on the degree of heat applied; but not to any serious extent (when working on the large scale), on the material of the retort. If an organic substance contain much infusible mineral matter, the latter will hold down the former, and compel recourse to a higher temperature. Thus gum-benzoin, when distilled alone, yields benzoate; when mixed with sand it produces benzene. In cases of this kind, the fine state of division or porosity of the earthy constituent contributes, with the higher temperature, to a change in the nature of the prevailing re-action." . . . At a very high temperature, the products from coal and shale are carbon and carbonised gases of low illuminating power, with but little liquid distillate; at a low temperature there is much liquid product, and comparatively little gas, but of high illuminating power.

* "Destructive distillation," by E. J. Mills, London. (Van Voorst).

Russia Leather.

The peculiar and much admired aroma of so-called "Russia leather" is due to the employment in the process of dressing the leather, of an empyreumatic oil, which is formed by the destructive distillation of the bark of the White Birch, *Betula alba,* Lin.

The extraction of Birch tar is an industry of some importance in Russia; the process is said to be conducted in the following manner:—An iron vessel is filled with bark and covered with a close-fitting lid, through which is inserted an iron pipe. On this is inverted a smaller iron vessel; the rims are carefully fitted together and well-luted with clay. The two vessels are then turned upside down, so that the one with the bark in it is uppermost. The apparatus is half sunk in the ground, well-banked with a mixture of sand and clay, and a wood fire is kindled around it. When the distillation has continued long enough, the luting is removed and the two iron vessels separated; the lower one is found to contain the tar and pyroligneous acid, the yield of tar being about one-third by weight of the bark used. In some districts the retorts are made of clay and the connecting pipes are of wood, but the receivers are always placed in the earth. The crude tar is a thick, black, empyreumatic fluid, which, when caused to cover in a thin layer the side of a bottle in which it is contained, has a dark brownish tinge. After a mere trace of it has been rubbed on the hand, an odour like Russia leather is perceptible. The Russian name for it, as pronounced by the natives, sounds to a person not conversant with the Russian language as "Dagget." On being re-distilled, a reddish brown oil is obtained; the yield being about 20 per cent. The distillers in Germany prefer the Polish to the Russian Birch tar.

The phenols of Birchwood tar have been investigated by Max Pfrenger (Archiv. f. Pharm., 29th December, 1890, p. 713), who worked upon an *Oleum betulini aethereum rectificatum* obtained from Schimmel & Co. The oil was a thin, light-refracting liquid, of a yellow-brown colour, acid in re-action, and having the odour of Russia leather; sp. gr. at 15° C., 0·956. After removal of free acid by treatment with soda solution, the oil was repeatedly shaken with caustic potash solution, the dark brown phenylate layer that formed on standing, separated and decomposed with dilute sulphuric acid, and the liberated phenols, amounting to 43·9 per

cent. of the oil, purified and fractionated. Their boiling points ranged from 181° to 200° C. As a result of the examination of the fractions, the conclusion was arrived at that the principal constituents of birch creosote are guaiacol and creosol, with smaller quantities of cresol and xylenol and probably traces of phenol. The portion insoluble in alkalies boils between 170° and 288°, about 20 per cent of it being between 170° and 200° C.

The birchwood cresote examined, would, therefore, like that from beechwood, appear to contain two series of homologous phenols; it is considered probable, however, that the relative quantities of the phenols would vary with the quality of the wood or bark and with the method of distillation.

Two qualities of oil of Birch tar are prepared by Messrs. Schimmel, of Leipzig, viz., crude and rectified. For the preparation of leather and soaps, and all purposes where the dark colour is not a disadvantage, the former kind should be used; the rectified oil is considerably weaker in aroma.*

Besides its use in imparting to leather the characteristic, penetrating and lasting odour, and acting as a preservative against the attacks of insects, the oil has established a reputation in Russia, Poland and Austria, as a curative in certain conditions of that intractible skin disease to which the general term eczema is applied.

In the outer bark of *Betula Alba* a substance was discovered by Lowitz in 1788, to which the name *Betulin*† has been given. It was considered to belong to a series of resins, including sylvic acid, which are produced by oxidation of hydrocarbons of the formula $C_{5n}H_{8n}$. It may be extracted by exhausting the dried bark with boiling water, drying it again, and then treating it with boiling alcohol. The solution on cooling deposits the betulin, which is pressed, dried and re-crystallised from ether.

Another process for obtaining it pure has been described as follows‡:—The outer bark of the White Birch, previously boiled with water and dried, is boiled for 3 or 4 hours with 20 times its weight of 90 per cent. alcohol in a vessel provided with an inverted condenser; the extract is strained while hot, and at once

* Bericht, April, 1891.

† Journ. f. Prakt. Chem., vii., p. 54; and xvi., p. 161.

‡ Liebig's Annalen, clxxxii, p. 368.

mixed with alcoholic neutral lead acetate so long as a precipitate is produced thereby.

The mixture again heated to the boiling point is filtered, and the filtrate is freed from lead by means of ammonium carbonate and allowed to cool, whereupon it deposits a mass of crystals of impure betulin, which may be purified by treatment with ether and crystallisation from boiling alcohol.

Pure betulin forms long, thin, colourless prisms, which, when dry, present the appearance of asbestos. It is inodorous and tasteless. It melts at 258° C. to a colourless liquid, which solidifies in a glassy, amorphous mass; at a somewhat higher temperature it begins to sublime in long, extremely delicate needles. When strongly heated it gives off vapours smelling strongly of Russia leather. It is insoluble in water; sparingly soluble in cold alcohol, ether, chloroform and benzene, but fairly soluble in the hot liquids. It dissolves also in glacial acetic acid and in oil of turpentine. Its composition agrees with the formula $C_{36}H_{60}O_3$. Betulin yields by dry distillation a number of volatile products, amongst which is one of thick oily consistence, boiling at 243°, of sp. gr. 0·951, and having the composition of *betulin anhydride* $C_{36}H_{56}O$, which is probably the principal aromatic ingredient of Birch tar, from which the commercial oil of Russia leather is obtained.

This oil must not be confounded with the Birch oil distilled from the *Betula lenta*, L., sometimes called "Sweet Birch," Cherry Birch and Mahogany Birch; this oil is totally different in character. (See "Gaultheria"). An oil is also distilled from the leaves of the Birch and the young leaf-buds of the poplar. See p. 345, 346.

An oil is produced in Japan under the name "Matsu oil," which is distilled from a tar of either the *Pinus Massoniana* or *P. densiflora*, and was at first thought to be derived from a Birch or Beech tar. Both these pines pass under the name of "Matsu" in Japan, so it is as yet uncertain which of them (or whether both of them) furnishes the supply, but the oil differs greatly in physical characters to the German oil; it has a sp. gr. of 0·875, and contains only 4 per cent. of phenols, having an agreeable guaiacol odour; the portion of the oil insoluble in alkalies boils for the most part below 180° (about 40 per cent. from 160° to 170°, and

40 per cent. from 170° to 180°), and only about 10 per cent. goes over at a temperature above 200°.

It is strange that the fine fragrance of the empyreumatic oil of White Birch bark should not have attracted the attention of chemists to products which may be obtained by the destructive distillation of other substances, for instance, Cascarilla bark.

Cascarilla.

The product so largely dealt in commercially as "Cascarilla" is the bark of *Croton Elutheria*, Bennett,* a small tree belonging to the Natural Order *Euphorbiaceæ*, native of the Bahamas, and especially abundant on the island Eleuthera of that group, from whence the chief supply is derived.

The *Elutheria* is a small tree, seldom exceeding twenty feet in height, and sending off numerous branches, especially towards the top; the bark of the small branches is brown and smooth, but that of the larger branches and trunk is externally more white and rough, and covered with a variety of lichens. The branches are brittle, and, when broken, ooze out a thick balsamic juice. The leaves are entire, ovate-lanceolate, somewhat cordate, and elongated towards the apex, which is blunt, and placed alternately on short petioles. The upper surface is studded with small orbicular scales; the under is whitish, shining and silvery. The flowers are in axillary and terminal spikes, and are composed of a calyx divided into five ovate leaflets, and an equal number of small whitish, oblong, obtuse petals. The male flower has ten awl-shaped filaments, bearing erect, compressed anthers. The female produces a roundish germen, supporting three bifid spreading styles, with obtuse stigmas. The capsule is oblong, marked with six furrows, and divided into three cells, each containing a solitary, oval, shining seed. For figure of the plant see Woodville Med. Bot., t. 211 (edition 1794); Bentley & Trimen, Med. Plants, t. 238. For microscopic structure of bark see Pharm. Journ. [3], iii., p. 664; Berg. Anat. Atlas, t. 37; also Flückiger & Hanbury, Hist. des Drogues, ii., p. 317.

The bark, as it arrives on the market, is in short, curled pieces, or in short quills. The latter, evidently the produce of the

* Proc. Lin. Soc., iv., p. 29.

younger branches, have a very thin periderm (outer layer), which is easily detached. The older pieces are rougher, split lengthways, and have many transverse fissures. The pieces are generally 2 to 3 inches long, but often mixed with a great deal of small fragments. The white crustaceous lichen attached to the outer surface is generally the *Verrucaria albissima*, Ach., and sometimes other varieties of *Verrucaria*.*

The inner surface of the bark is of a brownish-red. It breaks with a short, resinous fracture and has an agreeable aromatic odour. To the taste it is warm, bitter and aromatic. It burns readily, and whilst burning emits a remarkably fragrant odour, for which reason it is used as an ingredient in fumigating pastilles. The bark yields on distillation with water, or steam, 1·75 per cent. of a complex volatile oil of fragrant penetrating odour. This oil has a sp. gr. of 0·938 and begins to boil at 180° C. This first fraction is colourless, mobile and refractive; the second fraction is yellowish and rather thick. It was found by Tromsdorff, that the bark also contains 15 per cent. of resin, part of which gave an acid reaction and was soluble in alkalies, and part was neutral. It also contains gum in about the same proportion. The bitter principle contained in the bark is *Cascarillin*, $C_{12}H_{18}O_4$, which is a neutral substance freely soluble in ether and hot alcohol, but sparingly soluble in water, chloroform or dilute alcohol. This body melts at 205° C. and is not volatile. It is not a glucoside.

The barks of other species of croton have sometimes been found mixed with cascarilla bark in the bales as imported.† An instance was reported by the Curator of the Pharmaceutical Society's Museum,‡ as follows:—Of 4 serons, imported from Nassau, in the Bahama Islands, and purchased by one of the first London houses, three contained the true bark, but the fourth, which appeared to contain unusually fine specimens, and which were sent out as such, was afterwards found to consist almost entirely of a spurious bark. At first sight this bark strongly resembles cascarilla in appearance, but may be distinguished thus:—The periderm, or outer layer of bark does not readily peel off, and is of a fawn colour, not white. On the inner surface

* An enumeration of these growths on various trees is to be found in "Essai des Cryptogames des écorces exotiques officinales," par Fée.

† Pharm. Journ. [1], vii., p. 35.

‡ Pharm. Journ. [3], iv., p. 810.

the bark is of a reddish tint, and is furnished with a number of straight, closely packed, raised lines, which give it a striated appearance, the inner surface of the cascarilla being smooth. The taste is not aromatic but astringent, and almost without bitterness. The colour of the bark is also of a more reddish tint than that of cascarilla. From the general appearance and microscopic structure of the bark it seems probable that it may belong to a plant of the same genus as the cascarilla, probably *Croton lucidum*, Lin., which is said to be used by the negroes of New Providence to mix with the bark of the true cascarilla, under the idea that it improves the curative powers of the latter, and is known by the name of "false sweet-wood bark," sweet-wood being the name applied by them to the true cascarilla. Hence this bark may have been mixed with the cascarilla, by those who collected it, for the above-mentioned purpose; but from the fact of its only occurring in one seron, it is more probable that it was an intentional adulteration. The infusion and tincture of this false bark are darker in colour than those of cascarilla; the tincture of galls gives a scarcely preceptible cloudiness, and tincture of perchloride of iron turns the tincture almost black, while the infusion is only slightly deepened in colour by it, and acetate of lead gives an abundant precipitate with both tinctures. The tincture of true cascarilla is not altered in appearance either by tincture of perchloride of iron or tincture of galls.

Caffeone.—The process of coffee roasting is in reality a process of destructive distillation at a low temperature, stopped at a certain point. When coffee berries are properly roasted they should not have lost more than 18 per cent. in weight. If the loss exceeds 20 per cent. the flavour suffers in proportion. The empyreumatic oil produced varies, according to the source and condition of the berries, from 8 to 13 per cent.; of this, at least one-half is lost by the escape of its vapour, the other half remaining in the berries. The actual bodies given off from the berries during the operation are *Caffeone*, $C_8H_{10}O_2$; *Caffeine*, $C_8H_{10}N_4O_2$; fatty acids, chiefly palmitic; acetic acid; carbon dioxide, and small quantities of pyrrol, methylamine and quinol (this last derived probably from the quinic acid contained in the raw beans).

Caffeone, the aromatic principle of coffee, may be isolated by distilling 5 or 6 lbs. of roasted coffee with water, agitating the

aqueous distillate with ether and afterwards evaporating the ether. It can also be obtained from the crude empyreumatic oil of coffee by distillation with ether, and after separating the oil, agitating the aqueous distillate with water, as above. It is a brownish coloured oil, heavier than water, boiling at 195°-197° C., and possessing the fine aroma of coffee in a very powerful degree. It is slightly soluble in boiling water; an almost imponderable quantity of it is sufficient to aromatise more than a quart of water.* Its alcoholic solution gives with ferric chloride a red coloration which is not destroyed by sodium carbonate. It only dissolves with difficulty in concentrated caustic potash solution, and on fusion with caustic potash yields *salicylic acid.* It is therefore probably a methyl-ether of *saligenin*, and has the constitution $C_6 H_4 (O H) C H_2 O C H_3$.† The fact that it gives a red coloration with ferric chloride, which shows it to be a phenol, is in accordance with this supposition. Rotsch has also found that *hydroxybenzyl methyl ether,* which is isomeric with caffeone, smells strongly of burnt coffee, but loses the smell completely on purification. This behaviour may be explained by the formation of small quantities of caffeone as a by-product, to which the crude product owes its odour.

Hydroxybenzyl methyl ether, $C_6 H_4 (O C H_3) C H_2 O H$, is formed when *saligenin*, $C_7 H_8 O_2$, is heated with methyl iodide, caustic potash and wood spirit. It is a liquid which boils at 247°·5 C., and solidifies in a mixture of ether and solid carbonic acid to a glassy mass.‡

A method for preparing *Saligenin* was devised by Piria, as follows:—Fifty parts of salicin are put into 200 parts of water, and 3 parts of *emulsin* added (this substance being obtained by macerating pressed almonds with 3 parts of water for 24 hours and precipitating the solution with alcohol. See series i., p. 176). After 12 hours, the greater portion of the saligenin has crystallised out, and the remainder is extracted from the solution with ether. The crude product is then re-crystallised from hot benzene.§ Saligenin dissolves in 15 parts of water at 22° C., and in almost all proportions in boiling water, readily in alcohol and ether. It

* Pelouse and Frémy, Traité de Chimie, iv., p. 449.

† Ann. Chim. Phys., xliii., p. 440.

‡ Ber. Deutsch. Chem. Ges., v., p. 436.

§ Am. Chem. Journ., cxvii., p. 84.

crystallises in small rhombohedra or tablets, which melt at 82° and sublime at 100° C. It forms a bluish-red solution in sulphuric acid, and its aqueous solution is coloured deep-blue by ferric chloride. Saligenin is sometimes called *Salicylic alcohol.*

Caffeic acid, or more correctly *Caffetannic acid* (synonymous with *Chlorogenic acid.)** This acid exists in raw coffee berries to the amount of from 3 to 5 per cent. as a calcium and magnesium salt; according to Payen as a double salt of caffeine and potassium. According to Rochleder it is also found in Paraguay tea. It is prepared by mixing an alcoholic infusion of coffee or Paraguay tea with water to separate the fatty matter, then boiling the liquid, adding acetate of lead, decomposing the precipitate with sulphuretted hydrogen and evaporating the filtered liquid. It forms a yellowish brittle mass, which may with difficulty be obtained colourless in mammelated crystalline groups. It dissolves easily in water, less in alcohol; has an astringent taste, and reddens litmus strongly. It melts when heated, then chars, and gives off the odour of roasted coffee. Rochleder states that by dry distillation it yields water and a thick oil which solidifies on cooling, and consists of "oxyphenic acid." Pfaff states that the aroma of coffee is dependent on the products of decomposition of caffeic acid. There appears to be here an opening for experimental research. During the process of roasting coffee no considerable escape of oil vapour occurs until the berries turn brown. When they have acquired a chocolate brown colour they are turned out and exposed to the air so as to cool them very rapidly and prevent their burning. The oil vapour is thus lost, but might be saved by connecting the roasting drum with an exhauster, which would prevent the risk of the berries catching fire, and by attaching a condenser between the exhauster and the drum, it would be possible to collect and condense the vapour of the oil, which would be valuable as a *genuine* "essence of coffee." Or, in a more concentrated form, the pure caffeone abstracted from the crude empyreumatic oil could be combined with the proportionate quantity of caffeine and tannic acid, and employed either in the liquid form as an essence, or combined with sugar as a syrup or a

* Rochleder, Ann. Chem. Pharm., lix., p. 300, lxiii., p. 193, lxvi., p. 35; lxxxii., p. 196; Liebich, ibid., lxxi., p. 97; Stenhouse, ibid., lxxxiii., p. 244; Payen, Ann. Chim. Phys. [3], xxvi., p. 108.

candy or a lozenge, possessing in a condensed form the exhilarating properties and medicinal virtues of true coffee; easily portable, and convenient under many circumstances for making an extemporaneous cup of the cherished beverage. Much of the so-called "Essence of coffee" now vended is simply treacle and burnt sugar flavoured with coffee. When taken in excess, coffee exercises a very baneful effect on the system, and its abuse becomes a habit very difficult to break off; but in moderation it exercises a powerfully beneficial influence, retarding the waste of the tissues of the body, exciting the brain to increased activity, exhilarating without intoxicating, and to a great extent neutralising the narcotic effect of tobacco smoke. Chicory produces none of these physiological effects, but possesses medicinal properties which are not desirable in an article of diet.

Eupione. A hydrocarbon discovered by Reichenbach.* It forms the chief portion of the light oil of wood-tar, and is found in great abundance in coal-tar. It is also produced by the dry distillation of many organic bodies, such as fixed oils, caoutchouc, resin, bones, &c. It is found most abundantly in rectified bone-oil and in the oils obtained by the dry distillation of rape seed and hemp seed. According to Heese† it does not exist in the crude empyreumatic oils obtained from these several sources, but is produced in the process of purifying them by the action of sulphuric acid.

To prepare it from rectified bone oil, the oil is mixed with $\frac{1}{4}$ of its weight of oil of vitriol; the lighter and clearer liquid which rises to the surface is taken off and distilled with an equal weight of sulphuric acid and a small quantity of nitre; the distillate is again distilled with sulphuric acid, then washed with aqueous potash and with water, and after rectification is dried under the air pump and treated with potassium as long as the metal shows signs of oxidation.

It consists essentially, according to Frankland, of hydride of amyl, $C_8 H_{12}$. It is a colourless, extremely mobile liquid, having a very low refracting power. It is tasteless, but has an agreeable odour, like that of some flowers. Its sp. gr. is 0·65 at 20° C. It expands very much when heated; 100 vols. at 30° C. expanding to

* Ann. Chem. Pharm., xiii., p. 217.

† Ann. Chem. Pharm., xxiii., p. 247.

104·5 vols. at 47° C. It is very volatile, evaporating perceptibly at ordinary temperatures.

When dropped on paper it makes a greasy stain, which quickly disappears. It evaporates instantly on the skin, boils at 47° C., and distils unaltered. It is inflammable and burns with a smokeless flame. It is insoluble in water, soluble in aqueous alcohol, but mixes easily in absolute alcohol, ether and, oils both fixed and volatile. It dissolves fats, camphor and similar substances with facility, also caoutchouc when heated, the solution leaving a dry varnish when evaporated. It dissolves resins for the most part with difficulty and incompletely. Most alkaloids are quite insoluble in it, even at the boiling point.

Owing to its exceeding volatility, limpidity, and total absence of unpleasant residue on evaporation, it is suggested that this liquid would form a good solvent in the preparation of "concrete essences, where a solvent of low boiling-point and pleasant odour is desirable.*

Furfurol, $C_5 H_4 O_2$. During the preparation of *Formic acid* from a mixture of sugar or starch with dilute sulphuric acid and peroxide of manganese, Dœbereiner was the first to observe the formation of this oily, aromatic liquid, which he designated by the name of "Artificial oil of Ants."†

The experiments of Dœbereiner, repeated by Cahours, led to the inference that this product was not obtained when the same bodies were distilled with dilute sulphuric acid alone, without the peroxide of manganese. Emmet, however, states having obtained it by distilling sugar, starch, gum or wood with sulphuric acid in sufficient state of dilution to prevent carbonisation: as soon as the residue in the still became sufficiently concentrated to blacken the material acted upon, nothing passed but formic acid.

It was ascertained by the experiments of Stenhouse and of Fownes, that the oily body known as Furfurol (from the Latin *furfur*, bran, and *oleum*, oil) is always produced when dilute sulphuric acid is distilled with bran, corn or oat flour, cocoa-nut shell, the husk of linseed, or sawdust, particularly the sawdust of mahogany. It was also found that hydrochloric acid could be

* 1st Series, p. 63.

† Dœbereiner, Ann. Chem. Pharm., iii., p. 141; ibid., liv., p. 52; Pharm. Journ. [i.], viii., p. 113.

employed, but not so advantageously as sulphuric acid, as this last does not distil over with the furfurol.

The researches of Vœlckel* show that furfurol is also present in the oily bodies formed during the dry distillation of sugar.

The preparation of Furfurol has been described in several ways, as follows:—

1°—One part of sugar is distilled with 3 parts of manganese, 3 parts of oil of vitriol and 5 parts of water; the formic acid in the distillate saturated with carbonate of soda, the liquid re-distilled, the distillate saturated with chloride of calcium, and lastly, the Furfurol distilled off (Dœbereiner).

2°—One part of wheat-flour or sawdust is distilled with 1 part oil of vitriol diluted with an equal bulk of water in a copper still, which may be half filled with the mixture; the distillation being continued till the residue begins to char; the distillate, together with about as much water as was at first used, poured back into the still; the liquid redistilled nearly to dryness; the formic and sulphuric acids in the distillate (which is rendered milky by the furfurol held in suspension), saturated with potash; the resulting distillate mixed with a large quantity of chloride of calcium and partially distilled, and this process repeated if necessary, till the greater part of the oil, which is surmounted by an aqueous solution of itself, is obtained in a free state. By this means 100 parts of flour yield 0·52 parts of furfurol.†

3°—Two parts of oatmeal are heated with 2 parts of water and 1 part of oil of vitriol in a still, and the mixture well stirred till the pasty mass has become liquid from formation of dextrin; the liquid is then distilled: 1 part more of water is added as soon as sulphurous acid begins to escape; the distillation is continued till sulphurous acid comes off in large quantity; the whole distillate is then poured back into the still: half of it distilled off, and this half neutralised as in process 2, with potash, &c.‡

4°—One kilo of bran, 1 kilo of water, and half a kilo of concentrated sulphuric acid is introduced into a spacious retort and warmed until it becomes quite fluid; then having luted on the

* Ann. Chem. Pharm., lxxxv., p. 61.

† Stenhouse, Ann. Chem. Pharm., xxxv., p. 301; lxxiv., p. 278.

‡ Fownes, ibid, liv., p. 52.

condenser, a stronger heat is applied. As soon as sulphurous acid gas commences to be disengaged, 500 grammes of water are to be poured in upon the mass, and the distillation continued until the gas is given off in larger quantity. The distillate which has then passed over is put back into the retort, and the heat continued until half of the quantity of liquid which was in the retort has passed over. The product is then neutralised with calcic hydrate and redistilled. A heavy yellow oil then passes over, and a further portion may be obtained by rectifying the aqueous portion, which distils at the same time. The oil is dried over calcic chloride and finally rectified. In subsequent experiments, Fownes obtained by distilling 64 ozs. troy of wheat-bran, with 32 ozs. sulphuric acid, and an equal volume of water, 1 oz. of furfurol; and from 64 ozs. of wheat-flour treated in the same manner, 1½ dram. of impure furfurol.

5°—Cahours found that in preparing this oil, the proportion of sulphuric acid could be advantageously diminished:—6 kilos of bran, 5 kilos of sulphuric acid and 12 litres of water are mixed in a capacious still, and distilled till a strong odour of sulphurous acid is emitted. The distillate is partially and repeatedly rectified over calcic chloride. The yield in this way is 158 grammes of furfurol, equal to 2·6 per cent of the weight of bran used, but part of this yield is held in solution in the watery distillate, from which it may be precipitated by ammonia in the form of *Furfuramide*.*

Crude furfurol always contains acetone and another oil (*metafurfurol*), which, is very liable to rapid oxidation and resinification. These are easily removed by rectification. The product obtained from mahogany sawdust is purer than that obtained from bran or the husk of linseed.

To save the repeated rectifications, the first distillate may be immediately saturated with ammonia, the mixture set aside for 24 hours in a cool place and shaken occasionally. The furfuramide which separates is then to be distilled with dilute hydrochloric acid (not in excess), and the distillate rectified over chloride of calcium (Dœbereiner).

6°—According to Stenhouse, a very advantageous process is to distil bran with more than half its weight of sulphuric acid

* Cahours, Ann. Chim. Phys. [3], xxiv., p. 277.

previously diluted with 2 parts of water. Hydrochloric acid may also be used, but it has the disadvantage of distilling over with the oil. To obtain furfurol in large quantity, Stenhouse mixes 32 pounds of wheat-bran with 20 pounds of sulphuric acid diluted as first mentioned, in a capacious 3-necked glazed earthenware Woulfe's bottle (such as are used in the preparation of nitric and hydrochloric acids on the large scale). He then distils by passing steam into the mixture; neutralises the strongly acid distillate with chalk; rectifies the distillate repeatedly, and separates the oil by saturating the liquid with common salt, and re-distils. This process yields from 12 to 13 ounces of crude furfurol, containing a considerable quantity of *acetone*.

Schwanert proceeds in a similar manner,* using 100 pounds of strong sulphuric acid and 300 parts water to 100 parts bran, and obtains 5 parts furfurol, partly directly, partly after conversion into furfuramide by ammonia and subsequent decomposition of that compound by distillation with hydrochloric acid.

7°—Bran and chloride of zinc (in the proportion of 3 or 2½ to 1) in the state of solution strong enough to form a damp mass cohering in lumps, are distilled together, whereupon water passes over first, then furfurol, then hydrochloric acid, and lastly a solid fatty mass which floats on the surface, consisting of margaric acid and a small quantity of a hydrocarbon. The distillate is strained through linen, neutralised with potash, saturated with common salt, and rectified. The furfurol, after being separated from the water which passes over with it, is dried over chloride of calcium and again rectified. The watery portion of the distillate still contains a little furfurol, which may be converted into furfuramide, as in process 6. Six pounds of bran thus treated yielded from 1 to 2 ounces and sometimes more of furfurol. Bran containing a larger proportion of starch yields less.†

8°—The most abundant and economical source of furfurol is in the preparation of *Garancin*, by boiling madder with sulphuric acid. If the wooden boilers in which garancin is usually manufactured were fitted with condensers, furfurol might be obtained in any quantity without expense. Furfurol is also

* Ann. Chem. Pharm., cxvi., p. 257.

† Babo, Ann. Chem. Pharm., lxxxv., p. 100.

produced by boiling any kind of madder with solution of aluminium sulphide.

Crude furfurol prepared by any of the above processes requires to be rectified to purify it from *Metafurfurol*, with which it is always contaminated. The purity of the product may be tested by boiling an aqueous solution of the furfurol for a few minutes with caustic potash, and treating the dark yellow liquid with excess of sulphuric or hydrochloric acid. If metafurfurol is present, a deep red colour is produced; if not, the colour remains unchanged.

When recently prepared, Furfurol is an almost colourless oil, but it gradually changes by contact with the air, becoming darker even in the dark, and ultimately blackening. Under water these changes take place quickly. Pure Furfurol, which will not alter by keeping, can only be obtained by repeated rectification. It possesses great refractive power. Its odour resembles that of a mixture of cinnamon or cassia, and bitter almonds. Its taste is agreeable, resembling that of cinnamon. It has the property of staining the skin yellow. Its sp. gr. is 1·648 at 15°·6 C. Boiling point, 162°·8 to 163°·3 C. with the barometer at 29·9.* Stenhouse stated the boiling point at 166°,† and its solubility in 11 parts of water at 13° C. Fownes states it to be soluble in 12 parts of water at 15°·6 C. It is very soluble in alcohol. It volatilises unchanged, and is very inflammable, burning with a yellow, very smoky flame. It is related to *Pyromucic acid* in the same way as common aldehyde is to acetic acid. It likewise exhibits the characters of an aldehyde in combining with acid sodium sulphite.

A somewhat analogous product can be prepared by distilling certain marine algeæ *(fuscus vesiculosus, f. nodosus and f. serratus)* with dilute sulphuric acid. The resulting oil has the same composition and odour as furfurol, but it is a less stable body.

Metacetone. An oil occurring among the products of the dry distillation of sugar, starch, gum or mannite with lime. It also occurs among the volatile oils formed by the destructive distillation of wood. Frémy prepared metacetone by gently heating an intimate mixture of at least 500 grammes of sugar with

* Fownes, Phil. Trans., 1845, p. 253.

† Phil. Mag. [3], xviii., p. 132; xxxvii., p. 226.

8 times its weight of quicklime in a capacious retort, withdrawing the fire after a while, because the water, disengaged from the sugar, coming in contact with the lime, raises the temperature high enough to complete the reaction without further application of external heat. If the mixture has been well-made, scarcely any inflammable gas is evolved, and a complex oil passes into the receiver. This oil is shaken up with water to remove the acetone which it contains, and the residue which floats on water is rectified till it exhibits a constant boiling point. It is difficult, however, to obtain a pure product. According to Gottlieb,* it is best to use only 3 parts lime to 1 part sugar, and to keep the receiver cool. Metacetone is obtained in the same manner from starch, which even appears to yield rather more metacetone than acetone. Gum, on the contrary, yields a comparatively larger quantity of acetone.

Metacetone is a colourless oil having an agreeable odour, insoluble in water, very soluble in alcohol and in ether. Boiling point 84° C. It contains, according to the mean of Frémy's analysis,† 72·2 per cent of C, and 10·1 per cent of H. The formula $C_6 H_{10} O$, which represents it as isomeric with oxide of mesityl and oxide of allyl, requires 73·5 C, 10·2 H and 16·3 O.

Mesitylene, $C_9 H_{12}$, isomeric with cumene, is one of the numerous hydrocarbon products of the destructive distillation of coal, but it can be obtained in larger quantity from *acetone*, $C_3 H_6 O$ (formerly known as pyro-acetic spirit), one of the products of the destructive distillation of wood, thus:—One volume of commercial acetone is mixed with dry sand in a large tubulated retort, a cold mixture of one volume of sulphuric acid and half a volume of water being then allowed to flow into the retort in a slow unbroken stream. The liquid is allowed to stand for 24 hours and then distilled, the heat being carefully regulated; the first distillate consists of acetone and water, but is followed by the crude mesitylene, the receiver being changed as soon as oily bands appear in the retort. The distillate is washed with water and caustic soda, dried and purified by fractional distillation.‡ Hoffmann§ describes its preparation thus:—Two volumes of acetone

* Ann. Chem. Pharm., lii., p. 127.

† Ann. Chim. Phys. [2], lix., p. 6.

‡ Ann. Chem. Pharm., cxlvii., p. 42.

§ Journ. Chem. Soc. [i], ii., p. 104.

are distilled with 1 volume strong sulphuric acid, carefully regulating the heat. Two layers of liquid then collect in the receiver; the upper consists of very impure mesitylene and the lower contains sulphurous and acetic acids, resulting from a secondary decomposition. The upper layer is drawn off and rectified, first over the water-bath to separate undecomposed acetone, and then over the naked fire; but the product thus obtained does not exhibit a constant boiling point, and requires to be purified by numerous rectifications, and according to Cahours,* final distillation over phosphoric acid. It is a very light, colourless, strongly refractive liquid, having a slight, somewhat alliaceous, but not unpleasant odour. It boils between 155° and 160° C. according to Hoffmann's observation, but Cahours determined it between 162° and 164° C.

Mesitylenic acid, $C_9 H_{10} O_2$, or as now formulated, $C_6 H_3 (C H_3)_2 C O_2 H$. An acid isomeric with Xylic acid, and related to mesitylene in the same manner as benzoic acid to Toluene. It is prepared by boiling mesitylene for 16 to 20 hours with nitric acid of sp. gr. 1·4, to which two volumes of water have been added. The product is then, after complete oxidation, gently diluted with a large quantity of water and submitted to distillation. Nitromesitylene passes over first and then the acid, the distillation being continued until crystals of this are no longer deposited in the condensing tube, water being added to the residue in the retort as often as necessary. The acid suspended in the distillate is collected on a filter. The portion which still remains dissolved is obtained by neutralising the filtrate with sodium carbonate, evaporating to a small bulk and decomposing with hydrochloric acid. The acid thus obtained is added to that deposited on the sides of the condensing tube and to that remaining on the filter, which forms the larger portion. For complete purification the whole is boiled for some time with a small quantity of tin and concentrated hydrochloric acid, in order to remove any nitro-compounds, and the portion which remains undissolved, on cooling, is washed with water, dissolved in sodium carbonate and liberated by the addition of hydrochloric acid to the solution at the boiling point. The pure mesitylenic acid separates out on cooling, in dazzling white crystals.

* Comptes Rendus, xxiv., p. 255.

Mesitylenic acid is only soluble to a very small extent in cold water and with difficulty in boiling water, from which it crystallises in fine, small needles. It separates from alcohol, in which it is very readily soluble, in large, well-developed, monosymmetric crystals, while if boiling water be added to the dilute alcoholic solution until a permanent turbidity is produced, the acid crystallises on cooling in broad plates and needles, which closely resemble those of benzoic acid. It melts at 166° according to Fettig,* while Jacobsen gives 169° as the melting point, but sublimes below this temperature. Its salts have been examined by Fettig and by Fettig and Brückner.†

Ethyl mesitylenate, $C_9 H_9 O_2, C_2 H_5$, is formed by the action of hydrochloric acid on a solution of mesitylenic acid in absolute alcohol, and is a liquid which has a peculiar but pleasant smell considered to resemble that of attar of *roses*, boils at 241° and solidifies to a crystalline mass below 0°.

Other chemical products are reputed to possess the "odour of rose" (1st Series, p. 49) but so far as is at present known, that odour has not been matched by any combination or synthetical product, or is it to be found in nature in any other flower or plant.‡ Even in roses it is only developed in purity in the *R. centifolia* and *R. Damascena*; the perfume of other species and varieties being very distinct and of a very complex nature.

* Ber. Deutsche Chem. Ges., xi., p. 2054.

† Ann. Chem. Pharm., cxli., p. 129, and cxlvii., p. 45; and Zeitschr. [2], v., p. 169.

‡ The recent alleged discovery by Monnet and Barbier, of Rhodinol in oil of pelargonium, is referred to in the next Section.

SECTION IV.

ADDENDA TO VOLUME I.

(Generally referred to as Series I.)

VOL. I., P. 173.

Vanillin. For many manufacturing purposes this is superior to vanilla, as it is easily soluble in concentrated and dilute alcohol, water (especially hot water), ether, glycerine and petroleum jelly.

In confectionary and chocolate factories, pure crystallised vanillin can most advantageously be used in the form of a 2½ per cent. "Vanillin sugar," which, weight for weight, equals in aroma the best vanilla and should be used in precisely the same manner. To prepare it; take of vanilla crystals 6 drachms 15 grains, dissolve it in 4 fluid ounces of pure, odourless, absolute alcohol; pour this solution upon 2 lbs. 2 ozs. of the finest sugar and mix it thoroughly in order to distribute it as equally as possible. After having evaporated the alcohol in a warm place, and when the sugar has become thoroughly dry, it should be powdered in an earthenware mortar and sifted. It is then ready for use and may be kept an indefinite time without losing aroma. The yellow spots which occur on the sugar are caused by the vanillin. This 2½ per cent. Vanillin sugar should not be confounded with the "Vanilla sugar" generally used by confectioners. In order to prepare the latter, it is only necessary to add to pure sugar as much of the 2½ per cent. Vanillin sugar as would otherwise have been taken of the finest vanilla.

For liqueur making, vanillin is best used in the form of a 2½ per cent. "Vanillin essence," which, weight for weight, equals the the best vanilla in aroma, and is used exactly in the same way. To prepare it: take of vanillin crystals 6 drachms 15 grains, dissolve in 20 fluid ounces of pure, absolute alcohol and add 15 fluid ounces of distilled water.

The vanilla essence generally used for liqueur-making is prepared by taking for that purpose as much of the $2\frac{1}{2}$ per cent. vanillin essence as would otherwise have been taken of the finest vanilla.

For 100 litres (or 22 gallons) of liqueur, 5 grammes (77 grs.) of vanillin, or 7 fluid ounces of $2\frac{1}{2}$ per cent. vanillin essence are usually employed.

VOL. I., P. 1.

Musk. The last annual report of the Imperial German Consul in Shanghai contains the following remarks concerning Tonquin Musk:—"The discovery of artificial musk, which was brought to market in Paris and New York towards the end of the year 1889, caused such a panic among the importers at that time, that the price of genuine Tonquin Musk, which stood at 230 Taels per caddy as late as the autumn of 1889, fell to 200 Taels at the beginning of the year 1890, and to 130 Taels in June—July, 1890, keeping to the last-named low level until the commencement of the year 1891. This extraordinary fall in price brought about a decline of the shipments to Europe and America of from 2266 caddies in 1889 to 1194 caddies in 1890.* In the meantime it had been shown that the new discovery cannot be compared to the genuine Musk for delicacy, strength and durability of aroma. Confidence in the Chinese article returned, and in the year 1891 we were again able to show an export of 2033 caddies, and to report a very lively state of business. It is true that during the first nine months of 1892 the exports have been smaller than they were in the corresponding period of the previous year, and it is expected that the total shipments for 1892 will show a deficiency of about 25 per cent. as compared with those of 1891, but at the same time the musk trade continues to take a quiet and business-like course. Prices have again advanced, yet they remain so low, comparatively speaking, as to yield none but the very smallest profit to the Chinese dealers, and so have the effect of keeping down the supplies. The low quotations, as well as the competition

* The last quotation on the Shang-hai market was 180 Taels for finest Tonquin and 225 Taels for Dampi Musk. The latter kind is reputed to be particularly well liked in Paris. It occurs in round, thin-skinned pods. In Germany, as well as in England and in America, the preference is given to the Tonquin variety.

of a whole host of inferior and made-up preparations of musk, bar the way to any important improvement of the Musk trade. Nevertheless it is expected that the European and American markets will continue in the future to draw their annual requirements of between 1500 and 2000 caddies of musk from China."

"The chief interest of the Musk trade has lately been centered in Paris, which has rendered itself independent of the London market, by means of direct imports. Next to Paris and London, New York is also of some importance as an independent market.* The most saleable variety, and the one which enters almost exclusively into consideration so far as the European and American export trade is concerned, is the Tonquin Musk from Sze-chuen and Thibet. The cheaper kinds of musk from Yunnan, and of Carbadine musk, which is imported here (Shanghai) from Manchuria and Siberia, *via* Tientsin and Niu-Chwang, are chiefly used to supply the Chinese and Japanese requirements."

"The Musk business in China is exclusively in German hands."

Tonquin Musk is often adulterated (*i.e.*, lowered in quality and value) by the admixture of the well-known Assam variety, which is imported direct from Calcutta, in the grained state, in glass bottles. This variety is worth something like 35s. per oz. It is of weak flavour, and, in parts, has a repulsive odour of decomposed blood. With 70 per cent. of alcohol it yields a reddish tincture, whereas the tincture of genuine Tonquin Musk is of a dark-brown colour.

Vol. I. p. 9.

Musk "substitutes." Baur's second English Patent, No. 13613, dated 11th August, 1891, is described in the Specification as consisting of "a trinitro-derivative of a butylated meta-substituted phenol ether. By way of example, a mixture of methyl ether of meta-cresol and iso- or pseudo-butyl chloride is heated with aluminium chloride on the water-bath until no more hydrochloric acid is evolved. The product is poured into water, distilled with steam, and the butylated cresol ether isolated by fractional distillation. The ether is nitrated by introducing it gradually into

* And so is Germany, but the Consul omits to state it.

fuming nitric acid, or a mixture of nitric and sulphuric acids, and heating on a water-bath until a sample poured into water solidifies. The nitro-compound is separated by pouring it into water or on to ice, filtered, washed and re-crystallised from alcohol. Instead of butyl chloride, amyl or propyl chloride may be used in the preparation of the substituted phenol ether. The result may also be obtained by acting on other phenol ethers with amylene, butylene or propylene in presence of aluminium chloride. Again, the butyl, propyl or amyl radicle may be introduced into meta-cresol, the product nitrated, and the nitro-derivative converted into its ether, or the butylated, &c., meta-cresol may be first etherefied and afterwards nitrated."

The following opinion concerning "Musk substitutes" has recently been expressed by an eminent firm of manufacturing perfumers:—"The popularity of 'Musk Baur' in its present condition of quality is decidedly waning. Not only are the complaints of unequal strength on the increase, but the aroma itself proves to be thoroughly unsatisfactory. A vessel in which we keep our stock emits when opened a well defined odour of nitric acid. When used with too liberal a hand in soap-making, this compound produces a most abominable result, and injures the value of the soap considerably. After an almost interminable series of experiments in our own laboratory, and basing ourselves upon a prolonged observation of the qualities of the article, we are able to say that even so small a proportion as one gram. (15½ grains) of 'Musk Baur' added to 100 kilos (2 cwts.) of soap produces an insupportable odour. The largest admissable proportion is ½ gram. (or 8 grains) to 100 kilos (2 cwts.) of soap, but it is even preferable to take only half that quantity, viz., ¼ gram. We plainly state our conviction that 'Musk Baur' cannot be regarded as a valuable acquisition to the perfumery industry, and that on the other hand, in its present condition, it is rather calculated to deteriorate the value of the products scented with it. It is therefore necessary to pay serious attention either to the improvement of the present product or to the manufacture of an altogether new and better 'substitute,' as the present article can only serve to cast discredit upon the goods to which it is used. The preparation of the so-called 'Tonquinol' has already proved that it is possible to manufacture a vastly better product, and, looking at it from this standpoint, it is highly regrettable that this

last-named substitute for musk has disappeared from commerce as a result of the law-suit between the makers of the 'Musk Baur' and those of 'Tonquinol.' We are persuaded that this regret is echoed by many perfumers who have been accustomed to use Tonquinol."

A still more recent (October, 1893) and even more emphatic opinion, has been given by the same firm as follows:—"In consequence of numerous complaints with regard to the unequal condition of the artificial musk, which we have received, we have more closely investigated the chemical properties of this preparation. Even in the preliminary examination we have failed to recognise several properties ascribed by Baur* to tri-nitrobutyl-toluol (which is the chemical name for the preparation which he desires to be known commercially as 'Musk-Baur') and were therefore led to suspect that the commercial article could not be regarded as a uniform body, a suspicion which was proved to be correct by the chemical examination, of which we give details below. The 'artificial musk' examined by us had a melting point of 108°, and was fairly soluble in hot water, but only very slightly in petroleum-ether. On the other hand the melting-point of tri-nitrobutyl-toluol (according to Baur) is 96° to 97°, it is not soluble in water but dissolves easily in petroleum-ether. The process of our examination was as follows:—

"A fairly large sample of artificial musk, taken from a 10-gramme packet, was exhausted about 20 times with boiling petroleum-ether, in order to remove the tri-nitrobutyl-toluol present. The residue was dried, and six or eight times re-crystallised from hot water. This treatment resulted in the recovery of a nitrogenous body, separating from concentrated solutions in beautiful, thin scales, detachable like those of mother of pearl. From diluted solutions this body was recoverable in large flat crystals, occasionally reaching a length of $1\frac{1}{6}$ inch (3 c.m.) by $\frac{1}{5}$ inch ($\frac{1}{2}$ c.m.). In contrast to the original body, which possessed the well-known characteristic, penetrating and lingering odour of artificial musk, *the recovered product was absolutely odourless.* Its melting point was 111° to 113°. Upon heating these crystals with strong potash solution, a distinct odour of aniline was generated, and the subsequent addition to the alkaline solution of a few drops of

* Ber. Deutsch. Chem. Ges., xxiv., 2836.

chloroform at once gave rise to the exceedingly disagreeable characteristic odour of iso-nitrile. The indo-phenol reaction took place very beautifully with hydrochloric acid, carbolic acid, solution of chlorinated lime and ammonia, and after treatment with hydrochloric acid the addition of freshly prepared chlorine water produced a fine bright-blue coloration, which disappeared after some time. All these reactions pointed to the probability that the body under treatment was acetanilide. The correctness of this supposition was further confirmed by analysis and nitrogen-determination.

The analysis gave :—	Acetanilide requires :—	Tri-nitrobutyl-toluol requires :—
C = 71·217%	C = 71·111%	C = 46·643%
H „ 6·734 „	H „ 6·666 „	H „ 4·593 „
*N „ 10·639 „	N „ 10·370 „	N „ 14·840 „
O „ 11·410 „	O „ 11·853 „	O „ 33·924 „

"In order to make doubly sure, the bromine combination of the body was formed by dissolving it in glacial acetic acid, and saturating with bromine. The crystals separating after a short time from the acetic acid solution were re-crystallised from alcohol. Their melting point lay near 165°, and the crystals otherwise behaved exactly as does the bromine combination of acetanilide (paracetic bromine-anilide), of which the melting point is 165°.

"These examinations had made it clear that the artificial musk consists of two bodies, an odorous one, which is present in small proportions (probably tri-nitrobutyl-toluol), and an inodorous one, consisting of acetanilide ("antifebrin"). It now became a matter of interest to determine, at any rate approximately, the percentage proportion of odorous substance in the original preparation. Unfortunately the petroleum-ether process was not available for this purpose, acetanilide being sufficiently (though only slightly) soluble in petroleum-ether to influence the result too powerfully, considering the small proportion of odorous matter. On this account the determination of the nitro-groups according to Limpricht† as modified by Spindler‡ was resorted to. Although as recorded by

* Nitrogen estimation by Dumas' method.

† Ber. Deutsch. Chem. Ges., ii., p. 36.

‡ Liebig's Annalen, ccxv., p. 288.

Limpricht, this method has not given equally satisfactory results with all bodies, and although Spindler has occasionally noticed deviations amounting to from 3 to 4 per cent., such differences might be disregarded in the present instance, where only approximate results were aimed at. The nitro-determination of the well-mixed and dried artificial musk gave the following results with four different samples :—

I.	=	3·51	per cent. NO_2
II.	„	3·34	„ „
III.	„	3·03	„ „
IV.	„	3·13	„ „
Average	=	3·252	per cent. NO_2.

"The percentage proportion of NO_2 in tri-nitrobutyl-toluol being 48·76, it would follow that the artificial musk of commerce contains on an average 6·669 per cent. of tri-nitrobutyl-toluol; but making full allowance for the imperfections in respect of unequal reduction in the case of different nitro-bodies which exist in the above-mentioned process of nitro-determination, the conclusion is justified that "Musk-Baur" consists of a mixture of at least 90 parts of acetanilide ("antifebrin"), with, at the most, 10 parts of the odorous body, most probably tri-nitrobutyl-toluol.

"The body melting at 111° to 113°, already characterised above as acetanilide, showed, when experimentally subjected to the test for nitro-determination, a complete absence of nitro-groups. On the other hand the presence of 40·95 per cent. of NO_2 was proved in the residue of the petroleum-ether extraction, a substance appearing as a mass of crystals coloured dark through decomposition. It may therefore be assumed that this residue did not consist entirely of pure tri-nitrobutyl-toluol (requiring, as already stated, 48·76 per cent. of NO_2) and was still mixed to some extent with acetanilide. Unfortunately the smallness of the quantity of the residue rendered further purification and identification with tri-nitrobutyl-toluol impossible."

"In common with all other sellers and users of 'Musk Baur,' we had up to this point been under the impression that the commercial product consisted of the pure patented substance, a view which was certainly justified by the expensiveness of the article. But if, probably on account of greater convenience in use, this artificial

musk is diluted with about 90 per cent. of 'anti-febrin' (of which the value is about 1s. 6d. per lb.), and the mixture sold at a profit bordering upon the fabulous, consumers are at any rate entitled to expect that they shall be supplied with a uniform article of a definite, guaranteed musk percentage.

"As we have on former occasions repeatedly spoken well of 'Tonquinol,' a substance now withdrawn from commerce as a result of Patent litigation, we feel bound to state that this article also consisted chiefly of acetanilide. After this exposure, we trust that nobody will find fault with us for refusing henceforward to have any dealings in artificial musk, and for erasing the article from our Price List." (Schimmel & Co.).

"The firm which used to manufacture 'Tonquinol' has lately brought into commerce the following products, in which 'antifebrin' is likewise used as a vehicle:—

"Cumarol,"	consisting	of about	30 %	Coumarin	& 70 %	Antifebrin.
"Heliotrop,"	„	„	25 „	Heliotropin	& 75 „	„
"Bigarol,"	„	„	15 „	Nerolin	& 85 „	„
"Irisol,"	„	„	$2\frac{1}{2}$ „	Orris oil	& $97\frac{1}{2}$	„
"Ambrain,"	„	„	15 „	Coumarin	& 85 „	„

A special criticism of these mixtures may be dispensed with. It is difficult to qualify them by a term of sufficient force."

Vol. I., p. 1.

Ambrette. The seeds of *Hibiscus Abelmoschus* (Lin. Spec. 980). "Hibiscus" is one of the names given by the Greeks to "Mallow," and is said to be derived from *Ibis*, a Stork, a bird which is said to chew some of the species. "Abelmoschus" is derived from the Arabic *Kabb-el-Misk*, "grain or seed of musk." The "Mallow" group consists of a very large genus of *Malvaceæ*, characterised by their large showy flowers being borne singly upon stalks towards the ends of the branches; by having an outer calyx or involucel composed of numerous leaves, and an inner or true calyx cut into five divisions at the top, which does not fall away after flowering; by having five petals broad at top and narrow towards the base, where they unite with the tube of the stamens; and by the latter forming a sheath round the five-branched style, and emitting filaments bearing kidney-shaped

anthers throughout the greater part of its length. The fruit is five-celled, with numerous seeds. *Hibiscus abelmoschus* is a shrub of 6 to 8 feet in height. Native of the East Indies and South America. Its leaves are somewhat peltate, cordate, 5 to 7-angled, acuminated, serrated; stem hispid; pedicels usually longer than the petioles; involucel 8 to 9-leaved. Flowers sulphur-coloured, with a dark blue centre. Capsules conicle, covered with bristles. The seeds are large and have a very musky odour.* The seeds yield on distillation 0·1 to 0·25 per cent. of essential oil, which congeals at + 10° C. Its sp. gr. at 25° C. is 0·900 to 0·905 (Schimmel).

Vol. I., p. 19.

Eurybia argophylla. The **Silver-leaved Musk Tree.** The genus *Eurybia* are trees or shrubs of the Composite family, confined to Australia, Tasmania and New Zealand, and numbering upwards of sixty species. In many respects it is allied to *Aster*, of the Northern hemisphere, but the flower-heads do not contain nearly so many florets. *E. argophylla* is a native of Tasmania, attaining a height of 20 to 25 feet, with a girth of 3 feet. In England it is often seen in greenhouses as a shrub, being cultivated for the musky odour of its leaves.

Vol. I., p. 19.

Guarea grandiflora. **Musk-wood**, called also "Alligator wood," and by the French, in French Guiana, "Bois-rouge." The genus *Guarea* belongs to the Natural Order *Meliaceæ.* The flowers of this genus are in axillary clusters, with the stamens united in a cylindrical or somewhat prismatic tube, the free margin of which is entire or slightly waved, the anthers being enclosed within it. The ovary is 4-celled, placed on a stalk-like disc, and the capsule is 4-valved, with 4 or 8 seeds. The specific characters of *G. grandiflora* are: leaves large, leaflets many, in pairs, 8 to 9 inches long, ovate-oblong, feather-nerved, very

* Cav. Diss., iii., t. 62, f. 2. Rumph. Amb., iv., p. 38, t. 15. Rheede Mal., ii., p. 71, t. 38.

prominent nerves beneath. Racemes elongated; petals silky on the outside, 4 or 5 inches long; tube of stamens entire, not toothed at the apex; fruit roundish. Plumier, Plantarum Americanum, t. 147, f. 2; D. C. Prod., i., p. 624. Syn. *Melia guara*, Jacquin, Stirpium Americanum, p. 126, t. 176, f. 37, Lin. Spec. 551. This tree is a native of French Guiana and the Caribbee Islands, where it attains a height of 30 feet. All parts of the tree, especially the bark, smell strongly of musk. The wood is full of a bitter, resinous substance, which renders it unfit for making into the staves of rum hogsheads, being observed to communicate both its smell and taste to all spirituous liquors. Other species of this genus are more or less musk-scented, such as *G. Swartzii* (D. C. Prodr., i., p. 624). Syn. *Elutheria*, Browne, Civil and Natural Hist. of Jamaica, p. 369; Sloane, Hist. of Voyage to Madeira, Barbadoes, &c., ii., t. 170, f. 1; *G. trichilioides*, Swartz., Observations Botanicæ, 146. This is a tree of 20 feet in height, and is also a native of the Caribbee Islands.

Vol. I., pp. 13 and 374.

Ambergris. An opinion has been expressed by Beauregard* that ambergris may be considered as an amber-coloured calculus, containing a proportion of a black pigment and some excrementitious matters. "Pieces extracted from the intestines of the Sperm Whale appear to be formed by an aggregation of acicular crystals arranged in different positions. If examined under the microscope with the aid of polarised light, these crystals are readily differentiated from the surrounding mass by the brilliant colours displayed on revolving the prism," and it is suggested that the peculiarities of structure disclosed should be utilised for the rapid investigation of samples suspected to be adulterated.

Vol. I., p. 18.

Sumbul. Describing the starches in various root drugs, E. S. Bastin† states:—"The starch grains of sumbul are smooth,

* Journ. de Pharm., xxvi., p. 346.

† Apothecary, Dec., 1892.

oblong, round, or somewhat irregular, and often double. The hilum is central or sub-central, not unfrequently fissured with a single straight fissure or with a group of radiating ones. The one or two concentric circular lines about the hilum are usually unrecognisable until a swelling reagent is employed.

VOL. I., P. 328.

Santal-wood oil, estimation of. An examination has been made by Cripps* of several samples of santal-wood oil and cedar-wood oil. A table of colour-reactions is given, the most important of which are those with nitric acid, and hydrochloric acid and chloroform, the former giving a green tint with cedar-wood oil and the latter, a pink coloration in the acid layer, which are not produced by the different kinds of santal-wood oil.

NO.	ORIGIN.	SP. GR.	ROTATION 200 M.M.	SPIRIT TEST.	K H O REQUIRED FOR SAPONIFICATION.
1	"English," believed to be pure ...	976·5	−37°40′	No turbidity	0·44 %
2	Ditto	975·9		,,	0·80 ,,
3	Ditto	978·4		,,	
4	Macassar ...	972·0	−47°	8·0 c.c.	0·63 ,,
5	Reputed "English," 17 years old ...	963·0	+20°	5·7 c.c.	2·17 ,,
6	West Indian ...	967·5	+53°	8·4 c.c.	0·42 ,,
7	West Australian ...	952·0	+8°50′	15·0 c.c.	0·79 ,,
8	Ditto, from another dealer	967·0	+5°10′	3·05 c.c.	
9	Cedar-wood oil ...	950·0	+15°20′	0·25 c.c.	1·89 ,,
10	Ditto, from another dealer	945·4	+5°10′	0·40 c.c.	0·98 ,,
11	Ditto, ditto ...	967·4	+19°40′	0·65 c.c.	3·61 ,,
12	Ditto, ditto ...	970·0	−8°50′	2·20 c.c.	1·05 ,,

* Pharm. Journ. [3], xxiii., p. 461, Dec., 1892.

"The English distilled oil from East Indian Santal-wood dissolves readily in a mixture of 4 fluid parts of rectified spirit with one of distilled water, but the Macassar oil requires a large proportion of this mixture; this latter, however, forms a clear solution with five times its volume of a mixture of rectified spirit 5 fluid parts, distilled water 1 fluid part."

Cripps states that the spirit test is applied as described in a former note on Oil of Rosemary*, *i.e.*, Hager's method,† which is applied to essential oils as follows:—"One volume of the oil is dissolved in two volumes of absolute alcohol (sp. gr. 0·799). Dilute alcohol of sp. gr. 0·889 is gradually added from a burette until the liquid remains opalescent for one minute after agitation. In many instances the addition of another drop of dilute alcohol is sufficient to render the opalescent mixture milky white. If the liquid be turbid, but still translucent, a further addition of the diluted alcohol should be made, until the liquid is barely translucent, and this point is taken as the end of the reaction. It is very necessary to adhere rigidly to a certain temperature for carrying out this test, a difference of 2° C. making a perceptible difference in the number of c. c. of dilute alcohol required."

With a view to detect the presence of cedar oil, also of castor oil in santal-wood oil, the following trials of the spirit test were made:—

"Santal wood No. 1 in the preceding table with 12 per cent. of the cedar-wood oil No. 12 showed no appreciable difference from the pure oil. The addition to No. 1 of 14 per cent. of No. 12 required 14·5 c. c. weak spirit; 18 per cent. required 11·8 c. c. and 41 per cent. required 5·0 c. c.

"Santal-wood No. 1 with 5 per cent. of castor oil required 12·5 c. c. of the same."

"These results show that by this spirit test 5 per cent, of castor oil or 14 per cent. of the most soluble cedar oil can be detected in English distilled oil of East Indian santal-wood; had one of the less soluble samples been used, a smaller proportion would have been rendered evident. I find in fact that 10 per cent. of sample No. 11 can be detected."

"The saponification test is carried out as follows:—About 5

* Pharm. Journ. [3], xxi., p. 937.

† Allen's Commercial organic analysis, ii., p. 433.

grammes of the sample is accurately weighed into an Erlenmeyer flask, 10 c.c. of an approximately semi-normal alcoholic solution of caustic potash added, and the whole boiled under a return condenser for half-an-hour. Side by side with this another experiment is conducted as a blank, using only the potash solution. After the boiling, the remaining alkali is determined by titration with decinormal hydrochloric acid, using phenol-phthaleïn as indicator, the difference between the amount required in the two experiments being due to the alkali combined with the oil.

"Sample No. 1, to which 5·2 per cent. of castor oil had been added, required for saponification 1·45 per cent. of potassic hydrate, indicating 5·6 per cent. of adulterant, if we take 18 per cent. as the percentage required for castor oil. For the application of this test I should suggest that the amount of K H O required in excess of ·10 per cent should be multiplied by 5·5 to obtain the approximate amount of fatty oil, thus allowing a fair margin for somewhat abnormal samples of santal-wood oil."

In conclusion, Mr. Cripps suggests that the official description of the characters and tests of santal-wood oil should be modified as follows:—"Thick in consistence, pale yellow or nearly colourless, possessing a strongly aromatic odour, a pungent and spicy flavour and a neutral or slightly acid reaction. Its sp. gr. should not be below ·970. At 60° F. (15·5 C.) it forms a clear, or at most a faintly opalescent solution with five times its volume of a mixture of five fluid parts of rectified spirit with one fluid part of distilled water. It rotates the plane of polarisation of a ray of polarised light strongly to the left. Two drops of the oil added to six drops of nitric acid, sp. gr. 1·5, on a white tile should give a yellow or bright reddish-brown coloration, without any green, indigo, or violet tint at the edges during five minutes. For complete saponification in alcoholic solution, it requires not more than 1 per cent. of potassium hydrate."

Messrs. Schimmel & Co. state that the above Cripps' solubility requirements for a good quality oil are in accord with their own experience, as may be seen from the following table relating to a few samples of their own distillation* and add† that "Cripps' test is capable of being made somewhat more stringent by using

* Bericht, April, 1893.

† Ibid., October, 1893.

70 per cent. instead of 75 per cent. alcohol, at a temperature of 20° C. instead of 15°·5 C., and in the same proportion, viz., 1 to 5 parts by volume. West Indian santal-wood oil under similar conditions only gives an opaque solution with 50 to 70 parts of alcohol. Cedar-wood oil is not even soluble in 100 parts of 70 per cent. alcohol, but it gives a clear solution with 10 volumes of 90 per cent. alcohol. (We have never met with a lower sp. gr. than 0·975 in the course of many years' practice. That figure may therefore be taken as the lowest permissible sp. gr. of normal santal-wood oil)."

	SP. GR. AT 15° C.	OPTICAL ROTATION 100 M.M.
East Indian Santal-wood oil	0·979	− 18°20′
" " ...	0·976	− 17°20′
" " ...	0·976	− 18°40′
West Indian " ...	0·967	
" " ...	0·963	
" " ...	0·966	
" " ...	0·965	+ 26°10′
" " ...	0·965	+ 26°
Virginia Cedar-wood oil (*Juniperus Virginiana*) ...	0·949	
Ditto	0·946	− 36°40′
Ditto	0·947	− 38°22′
Ditto	0·948	− 34°28′

The higher sp. gr. of Indian distilled oil of santal is accounted for by Michael Conroy,* by the fact that in India the process of distillation adopted exposes the charge to the action of heat and water for the prolonged period of 10 days and nights. In proof of this explanation he placed one pint of English distilled oil of known density (0·975) in a jar with about 5 gallons of water, and kept the whole at a temperature of about 120° F. for 10 days and nights. The oil increased in viscosity, became darker in colour, and the sp. gr. increased from 0·975 to 0·989. The loss of oil in the experiment was half an ounce.

* Proc. Brit. Pharm. Conf., 15th August, 1893.

The quantity of santal-wood which will be placed in auction this year is estimated at from 2,000 to 2,250 tons,—this being a comparatively small quantity, the prices are expected to be high. The first auctions are held in the districts of Shimoga, Kadur and Hassan. Buyers are able to be present at these and yet to reach Mysore and Bengalore (where the chief sales are held), in good time. The chief storage places, called "Kothis" in first-named districts, are Hunsur, Seringapatam, Hassan, Chikmangalore, Jirthahalli, Shimoga and Shikapore. The total amount realized by these sales in 1890 was 882,031 Rs. The whole of the business is in the hands of Mohammedan Seits, who attend the auctions either on their own account or as agents of Bombay houses.

VOL. I., P. 372.

Rosemary oil. As doubts still appear to exist relative to the physical and chemical properties of this oil, it may be well to repeat more fully the results of the investigations made by Mr. Cripps and referred to at p. 372 of Vol. I.* The samples examined by him were as follows :—

No. 1.—A sample of oil distilled by myself in 1888 from fresh leaves and green shoots of my own plants grown in the South of England on a light, loamy soil over chalk.†

No. 2.—A similar sample distilled in 1890 from plants of that year. Both being supplied to Mr. Cripps in a state of absolute purity.

No. 3.—Received from Mitcham as "English oil," 1890.

No. 4.—Stated to be "a very fine Foreign oil."

Before subjecting the oils to chemical tests, they were thoroughly dried by prolonged contact with chloride of calcium and finally filtered.

PHYSICAL CHARACTERS. *Colour.* Nos. 1 and 2 are both nearly colourless, having a faint yellowish tint. No. 3 is of a more pronounced yellow, while No. 4 is even more coloured.

Odour. "It is almost impossible to describe the odour of

* Pharm. Journ. [3], xxi., p. 937.

† As described in Pharm. Journ. [3], xx., p. 937.

essential oils with any degree of precision; all the English samples possess an odour distinct from that of the foreign, a difference which is readily noticed by the most casual observer; the sample of foreign oil of rosemary is "softer," but also of far less "power" and less suggestive of lavender. The sample No. 3 differs somewhat from Nos. 1 and 2, having more the character of No. 4.

Specific gravity:—No. 1	....	0·911
„ 2	....	0·924
„ 3	....	0·901
„ 4	....	0·8835

The sp. gr. of foreign oil, as described by various observers, varies from 0·881 to 0·907.

Rotation. Only samples 1 and 4 were examined, the quantity at disposal being insufficient in other cases:—

No. 1	....	—9°35′
„ 4	....	—33°*

Solubility in Spirit. The method adopted in applying this test was the same as described in testing Santal wood oil (see above). The temperature of the room was 16°-17° C. The following results were obtained, using 1 c. c. of oil and 2 c. c. absolute alcohol:—

No. of sample.	C. c. diluted alcohol required.
1	Infinite
2	Infinite, slightly opalescent with 8·5 c. c.
3	2·65 c. c.
4	0·8 c. c.
No. 1, 3 pts. + No. 4, 1 pt....	4·2 c. c.
No. 1, 2 pts. + No. 4, 2 pts....	2·2 c. c.
No. 1, 1 pt. + No. 4, 3 pts. ..	1·1 c. c.

* The rotation of foreign oils of Rosemary varies greatly, but it is considered that in a state of purity they should be dextrogyre. The tabulated observations of various investigators omit to state whether the oils they examined were distilled from the green or the dried plant, also whether the woody stems were used or not, conditions which doubtless very much affect the result. It is known that the plant is sometimes distilled in the fresh state and sometimes in the dry—as in the island of Lesina, where it is dried for a week or two in the sun. S.

No. 1 was examined when about 6 months old and again about 9 months after, with the same result.*

CHEMICAL CHARACTERS. *Freedom from Petroleum, Resin, and other non-volatile substances.*—1 c. c. of each sample was evaporated in a platinum basin on a water-bath. Neither sample left any weighable residue, only just sufficient to render the dish slightly sticky.

Freedom from alcohol. To each sample a fragment of magenta was added (before the addition of chloride of calcium). Samples 1 and 4 remained free from pink coloration. Nos. 2 and 3 were very faintly coloured, but not more so than would be due to the trace of moisture present.

Reaction with Nitric acid. Two drops of the oil are added to 6 drops of nitric acid (sp. gr. 1·5). With each sample the following reaction occurred :—A bright orange-brown colour, then brisk effervescence, becoming at the same time paler in tint; No. 4 reacted much more violently than Nos. 1 and 2 and hissed slightly, No. 3. being intermediate. Dragendorff says, "Red, then brown, no hissing."

Reaction with Sulphuric acid. Two drops of the oil with 4 drops of sulphuric acid (sp. gr. 1·843) in each case assumed a pale orange-brown colour, becoming darker and redder by standing. Dragendorff says, "brown, then red-brown."

Reaction with Hydrochloric acid. This and the two following tests are taken from a paper by Charles Noel which appeared in L'Union Pharmaceutique, 1886-1887. They are modifications of tests originally proposed by Dragendorff.† Five drops of oil are mixed with 1 c. c. of hydrochloric acid (sp. gr. 1·16) and heated to ebullition; 4 c. c. of chloroform are added, the whole agitated, and then allowed to stand, the colour of the two layers of liquid being observed. With each of these oils the liquids remained almost colourless, the acid layer being faintly yellowish.

* Schimmel says (Bericht, April, 1891), foreign Rosemary oil dissolves at a temperature of 20° C. in ½ to 1½ parts of 90 per cent. alcohol, forming a clear solution. Further, on the addition of a larger quantity of the same alcohol the solution remains clear. Oil adulterated with American turpentine will be dextrogyre, but this sophistication will be readily recognised by the anomalous specific gravity and the difficult solubility in 90 per cent. alcohol.

† "Studies upon Essential oils," Pharm. Journ. [3], vi., p. 681.

Reaction with Brominated chloroform .To 2 drops of the oil contained in a dry test-tube, a solution of bromine in chloroform (about 5 per cent.) is gradually added, until a faint yellow coloration is produced; the mixture is then set aside for several hours. No distinct coloration is produced at once, but after standing some hours, each sample assumed a more or less greenish-blue hue. This was most marked in No. 3 and least in No. 2. No. 1 rather more deeply tinted than No. 4.

Reaction with ferric chloride. Four drops of the oil are added to 4 drops of solution of ferric chloride (Fr. Codex: 26 per cent. $Fe_2 Cl_6$ free from nitric acid) and 10 drops of sulphuric acid (sp. gr. 1·843) added. After 30 seconds 5 c. c. of carbon disulphide are added, agitated, and the disulphide poured off into a white dish. In each case the liquid was deeply coloured of a purplish-rose tint, which changed to dull-violet after several hours.

Reaction with powdered iodine. Applied in the usual way, scarcely any action took place with any of the samples.

*Phellandrene test.** This was applied only to Nos. 1 and 4, which gave negative results.

Action of Bromine. If Bromine be added drop by drop to Cineol, it is at first decolorised, but afterwards a red crystalline compound is produced. This, when kept in closed vessels, gradually runs to a liquid and finally deposits white crystals which melt at 125°·5 C. These consist of cinene tetrabromide. Wallach† states that cineol is present in oil of rosemary amongst other oils, which statement I can confirm, as I obtained abundance of cinene tetrabromide by treating English oil (No. 1) in the manner described.

Iodine absorption. I am of opinion that except in a few special cases, this test is of no value for *essential* oils, although very valuable for fixed oils and fats. In the case of rosemary, I have applied it only to sample No. 1, with which it did not give concordant results; consequently, I did not follow it up with the other samples. I append my results with those already published by others :—

* For the detection of Phellandrene, see p. 187 in article "Elemi."

† Wallach, in Pharm. Journ. [3], xviii. p. 481.

Barenthin	...	185%
Davies	...	325% *
Williams	...	161·7% (sp. gr. ·894, probably foreign, judging from sp. gr.)†
„	...	142·4% (sp. gr. ·912, probably English, judging from sp. gr.)

Sample No. 1.

2 hours	...	98·8%	mean
18 „	...	117·3%	„

Bromine absorption. I greatly prefer this to the last test for rosemary; in my hands it has given more concordant results, and the short time of digestion (fifteen minutes) is a decided advantage. In carrying it out I follow Allen‡ as employed for shale and petroleum oils. "An approximately decinormal solution of bromine is made by dissolving 2 c. c. of bromine in 750 c. c. of recently distilled carbon disulphide. This solution is rendered perfectly anhydrous by the addition of some lumps of dry calcium chloride. An accurately weighed quantity of the dry oil, weighing between ·2 and ·4 gram., or a measure of a solution in carbon disulphide, containing a known weight of the oil, is placed in a perfectly dry stoppered flask; the solution diluted to about 25 c. c. (I use 10 c. c.) with dry carbon disulphide, and then 25 c. c. of the bromine solution added. The flask is then closed and the contents agitated. If the liquid is distinctly red, sufficient bromine has been added, but should it be nearly or quite decolorised, a further addition of bromine should be made without delay. The flask is then at once placed in the dark and kept there for exactly fifteen minutes, when an excess of aqueous solution of iodide of potassium is poured in, the whole agitated, the flask removed to a light place and the solution titrated with decinormal solution of sodium thio-sulphate." Violent agitation is necessary towards the end of the titration, as the iodine remains dissolved in the carbon disulphide. Twenty-five c. c. of the bromine solution is treated exactly similarly in another dry flask; when the difference between the volume of standard thio-sulphate required in the two titrations indicates the amount of thio-sulphate corresponding to the bromine

* Pharm. Journ. [3], xix., p. 823.

† Chem. News., 1887, p. 175.

‡ Commercial Organic Analysis, p. 331.

absorbed by the oil. One c. c. of decinormal thio-sulphate is equivalent to 0·008 grm. of bromine. It is absolutely necessary not to expose the mixed bromine solution and essential oil to the action of daylight, but gaslight has no sensible effect. The time, 15 minutes, must be adhered to, or secondary reactions occur, vitiating the result. Finally, the temperature should be as near to 15°·5 C. as possible, and should on no account be above 17°·5 C. or below 15°·5 C.

Working in this way my results are as follows :—

No. 1	70·9 per cent.
Ditto about 9 months later	65·8 „
No. 2	70·5 „
No. 3	88·2 „
No. 4	108·0 „

Finally, I draw attention to the following points :—

Sample No. 3 does not *appear* to be wholly English oil.

Generally speaking, the sp. gr. of English oil is higher than that of the foreign.

English oil is more soluble in spirit than foreign.

The colour reactions of the oils are similar, although scarcely identical, but of little value for distinguishing the oils.

The bromine absorption of English oil is much lower than that of the foreign.

Vol. I., p. 224.

Cloves. A recent Consular report* supplies the following useful information on the Clove cultivation in Zanzibar (the most important cultivation of that island) :—

"The clove tree (a native of the Moluccas) was introduced into Mauritius in 1770 by the French, and at the end of the century an Arab accompanied a French officer from Zanzibar to Bourbon and obtained permission to take back a small quantity of seeds and plants with him. This was the commencement of the clove cultivation in Zanzibar, the Arab making the first plantation at

* No. 266, 1892.

Mitoni, on the road to Chueni, and the cultivation rapidly spread. The different methods by which this cultivation is now carried on are evidently borrowed from the French, and the Swahili word for clove 'garafa,' is probably a corruption of the French word, 'Giroflier.'"

It is grown wherever the soil is suitable, from the large and extensive plantations belonging to the Sultan and his family to the few trees owned by the more humble cultivator.

The soil most suitable for clove cultivation is a dark loam, having underneath a layer of dusky yellow earth intermixed with gravel, also a yellowish or reddish stiff clay; and these typical soils are found on the island. Certainly the clove tree requires clay, and I observed there was always a marked difference in appearance between trees growing in a clay soil—red for preference—and those found on a lighter ground; and the finest trees were always either growing on a red clay or else a stiff dark red to darker chocolate soil.

In establishing a plantation, the seeds are first soaked in water for three days, and when germination has set in they are planted out 6 inches apart, with the bud end above ground, into shaded beds,—the usual practice being to put down two seeds together in case of failure. If a large number of plants are to be grown, the seeds are only put down 3 inches to 4 inches apart. Beds are about 6 feet wide and of any length. They are shaded by a flat framework of sticks, over which is placed a layer of either dry grass or cocoanut leaves; the height of this framework is about 3 feet to 3½ feet: there is no regular rule for this, the important point being to keep the beds constantly damp. The slaves in charge go over the nursery beds morning and evening, watering wherever the surface has become dry, the practice being to sprinkle water with the hand from the water jar. This is done as long as the seedling has not thoroughly developed. When the plants are above ground, it is done every other day; when 6 inches high, once a week or ten days. The plants are kept on an average from 9 months to a year in shaded beds. When the plants are about 6 inches high they are by degrees hardened by the thatch of the framework being gradually removed, and they are then left in the open bed, freely exposed to sunshine for the space of one month or two months before planting out.

Special care is taken in planting out. The earth round the plant is loosened by a peculiar triangular-shaped spade used especially on clove plantations, and called "moaa," and in use in Zanzibar, as well as the ordinary native "jembe" or hoe. The plant is then carefully lifted out by the hand with as much earth adhering to the roots as possible, and placed upon two strips of banana fibre previously placed crosswise upon the ground. (Each strip of fibre is about 3 inches to 4 inches wide, by $1\frac{1}{2}$ feet to 2 feet in length). The four ends are then taken up, wrapped round the plant and firmly tied together. The plant is then carried to its destination, the strips of fibre effectually keeping the earth in position. Before planting, the pieces of fibre passing beneath are cut at each corner, and the plant finally placed in the hole prepared for it and the earth heaped round; the four ends of the fibre left at the sides are then removed one by one, the bottom portions being cut through, enabling this to be done with ease.

If the weather be hot, or in the event of drought, the young plant is watered in the evening daily, and watering is continued as required until the plant attains the height of 18 inches, or roughly speaking, during the space of one year. The young plants are not shaded in any way after planting. There appears to be great mortality among young plants and a good deal of supplying is required; a nursery being deemed indispensable for five years after a plantation is first opened up. (Probably were the plants shaded until established, their level raised and less frequently watered, and better hardened off before planting out, this excessive mortality would be checked). No ground or other cultivation is permitted amongst the cloves, but slaves everywhere appear free to cultivate their own plots and gardens amongst the trees, and I also observed cassava growing in a clearing of young clove trees. The general run of small "shambas" consists of cloves, cocoanuts, mangoes and other fruit trees, all planted indiscriminately and close together. No pruning whatever appears to be done and no manuring either, apart from fallen leaves, and this in the more favoured localities where the rows of clove trees shade the ground must add greatly to the fertility of the soil, the accumulation of leaves being considerable and the flat nature of the ground preventing wash.

There are now some trees growing on the island which are said to be nearly 90 years of age, but the average length of life of the

clove tree in Zanzibar appears to be from 60 to 70 years (on the authority of Mahomed-bin-Saif Drumiki, an elderly Arab of much experience, who has been for over 20 years in charge of the Sultan's plantation at Indo). Such terrible devastation resulted from the great hurricane of 1872, when nearly all the clove plantations on the island were destroyed, that the average age of the trees now growing may be put down as below 20 years, and the age of the trees in the Sultan's plantation, the largest in the island, is from 16 to 17 years.

"The appearance of the clove plantations is, as a rule, most healthy and luxuriant, the height of the more matured trees averaging fully 40 feet, and the branches of the two rows often completely shading the ground. Clove trees generally have forked stems, and often as many as three and four, and a single-boled tree is the exception.

"So far as I have been able to ascertain, the clove tree is not subject to any fungoid disease, and the percentage of dead, dying and unhealthy trees noticed by me was very small. The cause generally was either a damp situation, or else want of cultivation, and the presence of grasses, especially 'hook,' called in Swahili 'Pamba ya moitu.' The clove tree, however, suffers from the attacks of two enemies—one a caterpillar, which attacks the foliage in the dry weather and often denudes the tree of its leaves, but the tree recovers at once as soon as the rains set in. The other is the white ant, which occasionally attacks the roots. No remedial measures appear to be taken.

"In good situations the clove trees begin to yield in 5 years from planting, and in inferior soil in 6 years to 6½ years from planting. Cocoanut trees are generally planted at irregular distances between the rows of clove trees, but the reason for doing so appears to be quite forgotten, the usual reply being that 'it was the custom.' (Cocoanut trees are usually planted here and there amongst the clove trees in Amboyna and the Moluccas, it being believed that the proximity of this tree is beneficial to the clove. The French most probably adopted the custom in Mauritius and Réunion, and it eventually found its way to Zanzibar). The picking of the buds commences in August, and lasts for four months. On an average each tree is picked three times in a season. The unexpanded buds on the trees are at first a pinkish yellow, becoming a deeper red as they mature. The stalks and buds are gathered at the same time,

and thrown on to grass mats spread on the ground; the picking of the higher branches is done by means of triangular bamboo ladders. Other slaves pick off the buds from the stalks, and they are then spread out on mats to dry in the direct sunlight, and are taken in every night. The drying is continued for the space of 6 or 7 days, during which time they lose about 50 per cent. of their weight; thus 1 'frasila' (about 35 lbs.) of freshly gathered cloves is equal to ½ frasila dry. The colour desired in the dry clove is red; and buds of this colour are more valued than black.

"There is a duty to Government of 25 per cent.; this is paid in kind, and the cloves heaped in bulk in the Government 'godowns.' Public auctions of this are now held by Government every fortnight to allow open competition, and especially to admit European merchants.

"Zanzibar cloves are very dry, differing much in this respect from the Pemba produce, and can be stored for some time, but Pembas are disposed of as early as possible, as otherwise the loss from 'shortage' is very great. The latter generally arrive damp, and there is much 'shortage' when dried. A good dry sample of Pemba cloves is smaller and blacker — blacker from having contained much moisture. Zanzibar cloves are larger, the red appearance of the dried buds is unmistakable, and they are well known as 'Zanzibar red-heads.'

"Cloves are generally exported in double mat-bags ('makanda') in preference to gunnies, though there is more shortage—in fact, the difference is marked; these mat-bags, though double, apparently permit a greater amount of damp. The difference of shortage between Zanzibar and Europe equals 8 per cent. in the weight of the cloves. The difference between Zanzibar and Pemba cloves is well recognised in Europe, but large shipments of both varieties are also made to Bombay, where they are very probably mixed. Also large shipments of clove stalks are made to both Bombay and New York.

"The exports of cloves from Zanzibar for 1890-91 are as below:—

	1890.	1891.
Zanzibar ...	124,929 Frasilas ...	62,017 Frasilas (35 lbs. ea.).
Pemba	385,981 „ ...	326,986 „ „

"The average consumption of the world is estimated at 11,000,000 lbs."

VOL. I., P. 195.

Cinnamon. The shipments of Ceylon cinnamon chips from Colomba and Galle in 1892 were as follows:—

To the United Kingdom ...	...	97,829 lbs.
„ Austria	...	12,600 „
„ Belgium	...	64,344 „
„ France...	...	32,928 „
„ Germany	...	245,088 „
„ Holland	...	40,488 „
„ Italy	...	69,384 „
„ India	...	41,298 „
„ Australia	...	11,196 „
Total	...	615,155 lbs.

as compared with

1891	...	588,264 lbs.
1890	...	441,447 „
1889	...	562,543 „

The export lists for the first 3 months of 1893 also show large figures.

VOL. I., P. 205.

Cassia. From information obtained by Messrs. Schimmel & Co. direct from Messrs. Melchers & Co., of Canton, it appears that the Chinese oil of cassia is prepared in China from the leaves, leaf-stalks, flower-stalks of the "cassia-buds,"* and young twigs of the cassia shrub, which are by-products in stripping the bark.† Samples of the raw materials obtained from Canton have been examined,‡ and reported upon as follows:—

a. "*Cassia Bud-stalks.* Small, thin stalks about 1 m. m. thick and 5 m. m. long, possessing a strong and pure cinnamon taste. 614 kilos distilled by us yielded 10 kilos 120 gr., or 1·64 per cent of a beautifully bright oil with excellent sweet taste, indicating a high percentage of aldehyde.

* *Flores cassiæ immaturæ*, vol. i., p. 208.

† Ibid., p. 207.

‡ Schimmel & Co., Bericht, Oct., 1892.

We determined the sp. gr. to be 1·0463 and the aldehydic content 92 per cent.

b. "*Cassia leaves.* The dried, leather-like leaves with the strong petioles and small twigs. On mastication of leaves and petioles separately, both communicated a faint but pure taste of cinnamon, whilst the twigs exhibited strong cinnamon taste.

"In order to obtain exact results, we caused a certain quantity of the material to be sorted into leaves and stalks. 100 kilos of material yielded 85 kilos of leaves and 15 kilos of small twigs. On distillation the leaves yielded a beautiful sweet-smelling oil of sp. gr. 1·056 at 15° C. The aldehydic content was determined as 93 per cent. The thin twigs showed a less percentage of essential oil than the leaves, but this possessed a similar sweet taste to the oil from the leaves. The sp. gr. was 1·45 at 15° C. The aldehyde amounted to 90 per cent.

"The following parts of the cassia plant have been distilled by us with the appended results:—

"1.—Cassia bark, the 'Cassia Lignea' of commerce.
Yield of essential oil 1·5 per cent. Sp. gr. 1·035. Aldehyde content 88·9 per cent.

"2.—Cassia-buds, the *Flores cassiæ immaturæ* of commerce.
Yield of essential oil 1·550 per cent. Sp. gr. 1·026. Aldehyde content 80·4 per cent.

"3.—Stalks of the cassia-buds ('bud-sticks').
Yield of essential oil 1·64 per cent. Sp. gr. 1·046. Aldehyde content 92 per cent.

"4.—Cassia leaves, leaf-stalks and young twigs mixed.
Yield of essential oil 0·77 per cent. Sp. gr. 1·055. Aldehyde content 93 per cent.

"Nos. 1 and 2 are completely excluded as raw materials for the preparation of Cassia oil on account of the price.

"No. 3 is also out of the question, because the value, about \$4 per picul, is still higher than that of broken cassia, and because the yield would not be sufficient. It can therefore be assumed that the Cassia oil of commerce is distilled in China from the leaves, leaf-stalks and young

twigs of the cassia plant, probably together with various refuse products worthless for other purpose."

In a pamphlet by H. Schroeter, Hong-Kong, entitled, "Report on a Journey to Kwang-si," the writer reports from personal observation the following particulars of the manufacture of Cassia oil :—

"The shrubs destined for the production of the Cassia Lignea proper are partly stripped during the summer months of their minor branches and exceptionally juicy leaves. They are then conveyed in large bundles into the valley, where they are boiled in large vessels. From the aromatic juice thus obtained, the esteemed Cassia Oil is recovered by means of a most primitive distilling apparatus. As the Li-kin stations on the road to Canton levy an excessive duty upon the oil, in addition to that exacted by the Imperial Customs, the oil is carried in tins across the hills to Pakhoi and thence transported *via* Macao to Hong-Kong, instead of reaching Canton by the water-way intended by nature for its conveyance." The centre of the Cassia production is described as consisting of the Tai-Wo and Yung-Shun, districts in the province of Kwang-Si, and the prefecture of Lo-Ting in the province of Kwang-Tung.

The great differences observable in Chinese cassia oil (even when unadulterated) are probably due to having been distilled from different parts of the shrub or from another variety of the species *Cinnamomum*. Some samples have recently been imported into Germany, which contained a very low percentage of cinnamic aldehyde, 43, 44 and 46 per cent. only instead of 80 per cent., but yet, all these oils were of thin consistency and pale yellow colour, not differing in any way in appearance from the best commercial qualities, and they could not be proved to be grossly adulterated with resin, fixed oil or petroleum.* The Chinese maintain that such oils are perfectly pure and that they are always produced when fresh, imperfectly ripe raw material is used. This contention cannot be absolutely denied, as possibly a considerable proportion of aceto-cinnamic ether is present in the very young leaves, from which, in the course ef the maturing process, cinnamic aldehyde may be formed by oxidation.

* Schimmel & Co., Bericht., April, 1893.

Cassia oil of excellent quality has lately been distilled in Japan. Its sp. gr. has been determined as 1·059 at 15° C., and the aldehyde content 86 per cent.

VOL. I., P. 101.

Mignonette. Messrs. Schimmel & Co. have been the first to succeed in extracting the essential oil of this flower, and now state* that they prepare it upon an extensive scale at their factory near Leipzig. The oil occurs in a condition of firm consistency, similar to that of oil of orris. It is obtained by distillation at the lowest possible temperature from freshly-gathered mignonette flowers, and reproduces the lovely perfume of the mignonette in its full natural excellence; whereas it is notorious that the odour of this particular flower can only be communicated to fat by the maceration process in a very imperfect manner.

The yield of essential oil from Mignonette flowers is only 0·002 per cent.

Oil of mignonette is very economical in use, and on that account can be used in high-class perfumery, notwithstanding the enormous cost of its production. It gives a clear solution, with large quantities of alcohol. The oil is recommended to be used in the proportion of 1 part (by weight) to 500 parts of alcohol, and this solution employed for the composition of or addition to mignonette extract.†

VOL. I., P. 22.

Rose. Consular Report No. 1300 states that owing to untimely rains just before the rose harvest, the 1892 yield of otto

* Bericht, Oct., 1893.

† Messrs. S. & Co. have discovered that the fresh *root* of the mignonette contains an essential oil (the yield being 0·035%). The only relationship between this very curious oil and that obtained from the flowers is that both are derived from the same plant. As regards aroma they are almost at opposite poles, the root-oil possessing a strongly-marked radish odour. By a preliminary examination, Messrs. S. & Co. have determined the existence of sulphur in this oil. Contrary to mustard oil, this oil exists in the root as a separate and definite body. After drying, the root is odourless and tasteless. The sp. gr. of the oil is 1·085 at 15° C., and its optical rotation +1°30′ in a 100 m. m. tube (Bericht., Oct., 1893).

in Bulgaria was very small, amounting only to 1247 kilos. Another authority estimated the total yield as 1309 kilos. The 1893 rose crop in Bulgaria was nearly three weeks late, and fears were naturally entertained of a diminished yield, owing to the distillation taking place in a hotter period of the year than usual. But contrary to all custom, cool weather, accompanied by frequent rain showers set in during the first days of June, when the distillation was just commencing, and the flowers developed in such abundance, that, in spite of the damage caused by the early spring frosts, the crop turned out fully an average one, the otto-production of the season being estimated at about 1,800 to 2,000 kilos.

It will thus be seen that the climate in the Rose district south of the Balkans is very uncertain, and, considering the very valuable and profitable nature of the crop, it is advisable to seek elsewhere a convenient locality for establishing such plantations. Such localities possessing the requisite conditions of soil, aspect, temperature and reliably uniform climate could doubtless be found in many countries, notwithstanding the very misleading statements made by Bulgarian distillers and merchants in their trade circulars, statements which are of course made to guard their monopoly and deter enterprising competitors from establishing this industry elsewhere.*

Scientific researches into the nature of otto of rose have recently been made by Reformatzky and Markovnikoff, who have examined three samples sent to them by the Bulgarian Government. The following is an abstract of the most important portions of their paper†:—The oils turned the polarised ray of light to the left, as follows—3° 34·5′, 3° 53′ and 3° 20′. The separation of oil and stereoptene was effected by filtration at 0° and at —55°. From the liquid portion a principal fraction with a boiling point of 222° to 222°·5 was next isolated by fractional distillation. The analysis of a fraction boiling at 224°·7 gave the formula $C_{10}H_{20}O$. The authors call the principal constituent, which possesses alcoholic properties, "*roseol.*" From this roseol they prepared an acetic acid

* Vide the "World's Fair" Circular of Shipkoff & Co., Kezanlik; reproduced in "The Manufacturing Chemist," 20th January, 1894.

† Pharmaceutische Ztschr. für Russland, xxxii. (1893), p. 102; and J. Russ. Chem. Soc., xxiv., pp. 663-686.

ester, with a boiling point between 235° and 236°. Saponification of this ester resulted in the recovery of the roseol. The action of dehydrating agents converted the alcohol into a hydrocarbon of which the analysis responded to the formula $C_{10}H_{18}$, rather than to that of $C_{10}H_{16}$. Treated with chromic acid solution, roseol oxidised into an aldehyde of a lemon or melissa-like odour. Its sodium-bisulphite compound was crystalline.

Reformatzky and Markovnikoff believe that the stereoptene of otto of rose consists of a simple hydrocarbon of the fatty series; but in this they are mistaken, for, as already proved by Messrs. Schimmel, as far back as 1890,* from research into German oil distilled by themselves as well as into Bulgarian otto, hydrocarbons of quite different melting points (+22° and +40°) can be evolved with ease from the stereoptene, if the latter be experimented upon in large quantities. Hence the stereoptene cannot be a simple body.

The remaining results of Reformatzky and Markovnikoff's investigations are in contradiction with those obtained at one time by Eckart. According to the latter, the alcohol which gives the odour to otto of rose, answers to the formula $C_{10}H_{18}O$, from which by the separation of water, dipentene ($C_{10}H_{16}$) is formed. This has recently been thoroughly confirmed by Barbier,† who obtained bi-hydrochlorate of dipentene by treating rhodinol with dry hydrochloric acid. From this combination he liberated the dipentene, which he recognised by its tetra-bromide melting at 124°. Barbier also obtained the acetic ester of rhodinol. It yielded back unaltered rhodinol upon saponification and possessed the formula $C_{10}H_{17}OC_2H_3O$; whereas, according to Reformatzky and Markovnikoff, its formula is $C_{10}H_{19}OC_2H_3O$.

German Otto of Rose. The yield of this fine product from the rose plantations belonging to Messrs. Schimmel & Co. has been greatly reduced (in *quantity*) by the abnormal drought which prevailed during the flowering season, and those parts of the land which are as yet beyond the reach of artificial irrigation have suffered in an exceptional degree. The October Report issued by this firm states that the flowers were of the choicest description,

* Bericht, October, 1890.

† "Derivés and constitution du rhodinol de l'essence de roses, Comptes Rendus, cxvii., p. 771.

and the factory, constructed on the most rational principles and provided with the most suitable installation, has fulfilled its part altogether satisfactorily. " The unsurpassed *quality* of this year's distillate shows clearly the great value, or rather the absolute necessity, of distilling the flowers immediately after gathering. By the present arrangement the lapse of time between the gathering and the distillation is reduced to a few minutes. The factory itself lies close to the Klein-Miltitz station of the Thuringian Railway at the southern end of a rose-field extending without interruption over a surface of about 50 acres. The hall in which the roses are placed when they reach the factory, faces north and is exceedingly cool, while in the factory itself, care has been taken to secure the lowest possible temperature by placing the work-rooms in the basement. Each one of the four stills in the factory can easily accommodate a charge of 30 cwts. of roses, and the combined plant is able to extract without difficulty the otto of 40 tons of roses in the space of 12 hours. In addition to the stills, the factory contains special contrivances for the preparation of rose-water. The stills are charged and emptied automatically in the course of a few minutes, and a few hands are sufficient to deal with the out-put of a whole working day. The total heating surface of the boilers covers about 360 square yards. Although extreme cleanliness is observed throughout the rooms used for the preparation of the oil of roses, it is nowhere carried to greater perfection than in the apartments devoted to the manufacture of rose pommade. In these, floor and walls (the latter covered with China tiles), dispute the palm of cleanliness to the glittering centrifugal machines and boilers." The Report continues :—" We continue to make a speciality of the manufacture of *Rose-water* in two strengths, viz :—

" Double "	...(two pts. by weight of roses to one pt. of water)			
" Sextuple "	...(six	,,	,, to one	,,

Both are obtained directly from the roses, and *not* as a by-product in the distillation of rose oil. The sextuple rose water represents the *highest obtainable concentration*. If placed in ice over night, small drops of oil, clearly discernable, separate out on the surface. Given normal flowers, a rose-water prepared from more than six times its weight of roses would only retain the whole of its oil in solution at a temperature below the normal point, and thus become

practically useless. Such designations as 'ten-fold rose-water' are pure fictions."

VOL. I., P. 370.

Lavender. Investigations into the chemical composition of oil of lavender have been made by Bertram and Walbaum;* by Semmler and Tiemann,† and by Bouchardat;‡ also by Messrs. Schimmel & Co.,§ and Hirschsohn.||

The published results indicate that lavender oil contains, in addition to the esters Linalöol-acetate, Linalöol-butyrate and Geraniol-acetate, large quantities of free Linalöol, identical with Licareol. The determination of the ester was made without difficulty,¶ and is of great importance. A high proportion of ester is always a favorable sign, but even an oil with a low percentage of ester must still be considered good if it contains a large proportion of Linalöol to make up this deficiency. An ascertained quantity of oil is saponified with 20-30 c. c. m. of an alcoholic potash-lye, and the excess of the potash employed determined by titration with normal sulphuric acid. Seven experiments with oil of the same sample of the best quality gave the following results:—

	WEIGHT OF OIL.	KOH REQUIRED FOR SAPONIFICATION.	PERCENTAGE CALCULATED UPON LINALÖOL-ACETATE.
1	2·49 gr.	0·2352 gr.	32·8 per cent.
2	4·02 "	0·3700 "	32·1 "
3	5·51 "	0·5170 "	32·9 "
4	3·17 "	0·3025 "	33·3 "
5	4·72 "	0·4345 "	32·2 "
6	3·35 "	0·3130 "	32·6 "
7	3·49 "	0·3355 "	33·6 "

* Journal für Praktische Chemie, 1892, xlv., p. 590.

† Ber. Deutsche Chem. Ges., 1892, xxv., p. 1180.

‡ Comptes Rendus, cxvii., p. 53.

§ Bericht., April, 1893, and Oct., 1893.

|| Journ. für Pract. Chem., xlv.

¶ Schimmel in Journ. für Prakt. Chem., xlv., p. 594.

Ester percentages of other lavender oils from various sources were found to be as follows :—30 per cent., 36 per cent. (in two cases), 33·8 per cent., 34·2 per cent., 39 per cent., 32·8 per cent., 30·7 per cent., and 31·5 per cent. (Pure oil from the *dried* flowers gave 22·2 per cent.). It follows therefore that 30–33 per cent. may be taken as a fair standard percentage for a good sample of lavender oil.

In order to find out whether the ester-determination is reliable in the presence of large quantities of Turpentine oil, mixtures were made of the latter oil with a lavender oil testing 32–33 per cent, of linalöol-acetate and the ester percentage of the mixture then determined, the result being as follows :—

	DESCRIPTION OF MIXTURE.	ESTER PER CENT. PRESENT.	ESTER PER CENT. ESTIMATED.
1	Lavender oil with 10 % of turpentine	29	29·5
2	,, ,, 20 ,, ,,	25·3	26·0
3	,, ,, 30 ,, ,,	23·4	22·8

Messrs. Schimmel & Co. state that experiments for the quantitative determination of free linalöol in lavender oil have not yet attained the desired result, but in their investigations they have made use of the relatively favourable affinity of linalöol for acetic-anhydride, with which it combines to form linalöol-acetate. In these experiments, made with mixtures of linalöol-acetate and linalöol and terpene (limonene), 10 c. c. m. of the mixture were boiled with acetic anhydride and sodium acetate in a reflux stoppered glass retort, and the mass, after cooling, warmed with three times its volume of water and shaken in order to decompose the excess of the anhydride. After washing out with water and with baryta-water, the ester percentage of the dry neutral product was determined by saponification.

First mixture:—33 per cent. Linalöol-acetate, 47 per cent. Linalöol and 20 per cent. Limonene.

HOURS BOILED.	VOLUME OF ACETIC-ANHYDRIDE USED.	ESTER PERCENTAGE OF RESULTING PRODUCT
2	1	69·93
2	1	69·93
3	1	67·14
3	1	68·95
1	4	71·33
2	4	64·68
2 *	3	49·30

Second mixture:—80 per cent. Linalöol-acetate and 20 per cent. Limonene.

HOURS BOILED.	VOLUME OF ACETIC-ANHYDRIDE USED.	ESTER PERCENTAGE OF RESULTING PRODUCT
0·3	3	24·47
1	1	60·84
1	2	60·
2	1	68·2

It follows from these instances that the etherification occurs most completely after two hours' boiling with an equal volume of anhydride, and that wherever constant conditions are observed it results in figures admitting of comparison, but is yet nowhere really quantitave. The resulting product of the second mixture, for instance, should have contained 83·5 per cent. of ester if the 80 per cent. of linalöol had been completely converted, but as a matter of fact it only shows 68·2 per cent. Similarly, the first mixture only gave 69·93 per cent. instead of the theoretical 82·2 per cent.

* Heated to 100° C. only.

Applying this method to lavender oils:—A lavender oil containing 33 per cent. of acetate was etherified in the above manner. Eight experiments resulted as follows:—

QUANTITY.	K O H REQUIRED FOR SAPONIFICATION.	ESTER PERCENTAGE OF THE RESULTING PRODUCT	LINALÖOL PERCENTAGE OF DITTO.
1·70 gr.	0·30914 gr.	59 per cent.	46·4 per cent.
2·61 ,,	0·4264 ,,	57 ,,	44·4 ,,
2·58 ,,	0·43706 ,,	59 ,,	46·4 ,,
2·03 ,,	0·3305 ,,	57 ,,	44·4 ,,
1·825 ,,	0·2985 ,,	57·4 ,,	45·1 ,,
1·80 ,,	0·2932 ,,	57·4 ,,	45·1 ,,
1·90 ,,	0·30914 ,,	57 ,,	44·4 ,,
2·50 ,,	0·4264 ,,	59 ,,	46·4 ,,

Here also, acetylisation produced comparable figures. The percentage of linalöol calculated from the ester percentage ascertained, does not, of course, agree with that of the oil. The latter is really much greater.

The etherification of various lavender oils resulted as follows:—

	ESTER PER CENTAGE BEFORE ETHERIFICATION.	ESTER PERCENTAGE OF THE RESULTING PRODUCT
a	30 per cent...	65 per cent.
b	31·5 ,, ...	60·7 ,,
c	32·8 ,, ...	56·2 ,,
d	30·7 ,, ...	59·4 ,,
e	22·2 ,, (pure oil from *dried* flowers)...	64·6 ,,

Experiments made with mixtures of lavender oil and turpentine resulted as follows:—

					PER CENT. ESTER.
A lavender oil	mixed with	10%	of turpentine	showed	53·85
,,	,,	20	,,	,,	51·4
,,	,,	30	,,	,,	46·15

These examples prove that Lavender oil contains a large percentage of free linalöol.

The ester-determination constitutes a distinct advance in the methods of examination of lavender oil, and it should always be carried out in addition to the determination of the specific gravity and the optical rotation.

Spike oil, which is also a common adulterant of lavender oil, contains about 30 per cent. of an alcoholic body, but only small quantities of ester. Hence the addition of Spike oil to lavender oil decreases considerably the ester percentage of the latter. The surest method of detecting the presence of Spike oil is to test the suspected sample for the presence of Cineol, which is a constituent of Spike oil, but does not occur in lavender oil.

Messrs. S. & Co. further remark that they have convinced themselves that all samples of Lavender oil of unimpeachable excellence are soluble in three times their volume of 70 per cent. alcohol.

The formation of linalyl-acetate has been studied by Bouchardat,* who states that acetic anhydride reacts with linalöol at the ordinary temperature, and appears to cause the formation of the corresponding ether, from which the linalöol may be regenerated, but the reaction is slow and incomplete. As soon, however, as the temperature is raised and maintained for some time at 100° to 120°, combination takes place, and the rotatory power disappears, but at the same time an acetic ether is formed, which is a derivative of another alcohol. This ether has a density of 0·9377 to 0·9467 at 0°, and possesses a very agreeable odour, recalling that found in the oil of *Lavandula vera.* Saponified with alcoholic potash at 100° a neutral compound, $C_{20} H_{18} O_2$, is formed, which boils at 226° to 231° with slight decomposition, is totally inactive when polarised, and has a density of 0·9061 at 0°. It combines with four equivalents of bromine, which it decolorises instantly like linalöol, a body being formed which is crystalline or oily, according to the temperature employed. The alcohol has an agreeable rose odour, and has been proved to be identical with geraniol, the chief ingredient of all geranium oils, and which is isomeric with linalöol and closely allied to oleginic alcohol. The various geranium oils also contain, in addition, other constituents at present unknown.

Geranium (p. 44).

* Comptes Rendus, cxvi., p. 1253.

Chemically pure geraniol prepared by Messrs. Schimmel & Co.* was found to possess the following properties:—

Boiling point 231°-232°; and at 10 m. m. 112°.

Sp. gr. 0·884 at 15°.

Inactive to polarised light.

Refraction n_D 1·47734 at 19°.

The etherisation was accomplished quantitatively, according to the method described under lavender oil.

The saponification of the ester resulted as follows:—

1·69 gr.	required	0·4870 gr.	of K O H	= 100·5%	Ester
1·52	"	0·4368	"	" 100·3	"
1·89	"	0·5320	"	" 98·5	"

The ester estimation of Geranium oil by the same method yielded the following result:—

					PER CENT. ESTER.
Spanish Geranium oil	2·01 gr.	required	0·4704 gr.	K O H	= 81·8
Réunion "	1·89	"	0·4256	"	" 78·7

Although the key to the estimation of Geranium oil undoubtedly lies in the determination of the geraniol percentage, such determination cannot lead to certain results until the other constituents of the geranium oils are positively known, and research into the still unknown bodies present in these oils is absolutely necessary.

Monnet and Barbier endeavour to prove that they have separated Rhodinol from the essential oil of Pelargonium.† It requires confirmation.

Ph. Barbier has completed his researches on the open chain alcohols of the formula $C_{10}H_{18}O$, by studying the geraniol extracted from the oil of *Andropogon Schœnanthus.*‡ Referring to Semmler's investigation of the constitution of this alcohol, he points out that the resulting formula seems to indicate the existence of a stereo-isomer having the same relation to geraniol as licareol to licarhodol. Acting upon geraniol with acetic anhydride in a closed vessel at 150°, the only product was geraniol acetic ether, $C_{10}H_{17}O, C_2H_3O$, a colourless liquid of agreeable odour, boiling at 129°-130° under a pressure of 14·5 m. m.;

* Bericht., April, 1893.

† Comptes Rendus, cxvii., p. 1092.

‡ Comptes Rendus, cxvii., p. 120.

sp. gr. at 0° C. = 0·9388: refractive indices at 24°, n = 1·4614 for λ 645, and n = 1·4758 for λ 452·6. When heated with alcoholic potash, this acetate rapidly hydrolises and yields pure geraniol, a colourless, slightly oily liquid, with a fine odour; it boils at 126°–127° under a pressure of 16 m. m.: sp. gr. at 0° = 0·9012; refractive indices at 24°, n = 1·4750 for λ 645 and n = 1·4904 for λ 452·6. Treated with dry hydrochloric acid gas the geraniol gave a liquid dichlorhydrate $C_{10}H_{18}O_2$, boiling at 142°-143°, and this decomposed by means of a boiling acetic solution of potassium acetate, formed dipentene. Geraniol is therefore regarded by Barbier as presenting itself as the stable stereo-chemical modification, its passage through the acetic combination resulting in no isomeric change, but only in the purification of the compound. With regard to Bouchardat's claim to have transformed linalöol into geraniol, Barbier points out that if linalöol is identical with licareol, as the former asserts, the products of the reaction described must be licarhodol and not geraniol, these two alcohols being totally different both in their constitution and properties. Judging from Bouchardat's results, he is of opinion that the linalöol of oil of spike is nothing but an unstable stereo-isomeric modification of geraniol, playing the same rôle with regard to that as licareol to licarhodol, and thus confirming and aiding in the generalisation of facts previously submitted.

Vol. I., p. 45.

Indian Geranium. The authors of the "Pharmacographia Indica" (1893) give the following interesting information concerning oil of *Andropogon Schœnanthus*:—"The oil distillers in Khandesh call the grass "*Motiya*" when the inflorescence is young and of a bluish-white colour; after it has ripened and become red, it is called "*Sonfiya*." The oil obtained from it in the first condition has a more delicate odour than that obtained from the ripened grass. The motiya oil is usually mixed with the second kind, which, by itself, would not fetch a good price in the European market. (This may to a great extent account for the considerable difference in the quality of the two commercial "grass oils," the so-called geranium oil" and "ginger-grass oil.")

In the valuable work above quoted from, Dr. Dymock says:—"The grass grows freely, though not very widely, on open hill-sides in West Khandesh, especially in Akráni. The original seat of manufacture was Pimpalner, but as the oil is in great demand, the manufacture has of late spread to Nandurbár, Sháháda and Taloda. The makers are Mussulmen, who, at the close of the rains, about September, when the grass is ripening, buy it from the Bhils, stack it and set stills at the sides of brooks where wood and water are plentiful. The distillation process is of the most primitive description. The authors, after describing it, proceed—"In 1879-80, the number of stills was 197, producing about 71 cwts. of oil. More than 100 stills are worked in Nandurbár alone, and the increase of the manufacture is prevented only by the scarcity of the grass. The oil is packed in skins, and sent on bullock-back over the Kundaibári Pass to Surat, and by Dhulia and Manmad to Bombay."

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Lign-aloe. *Licareol* is the name given by Ph. Barbier to a primary alcohol of the fatty series, boiling at 199° to 200° and answering to the formula $C_{10}H_{18}O$, which he has found in the oil of *Licaria Guianensis* (Guiana and Brazilian Lign-aloe, known locally as "Licari-Kanali"), the products of which have been the subject of a series of notes in Vols. cxvi. and cxvii. (1893) of the Comptes Rendus. The optical rotation of this body is —18° 21′. Upon being heated with acetic anhydride to 150°, it afforded a hydrocarbon, $C_{10}H_{16}$ (*Licarene*), boiling at 176° to 178°, optical rotation + 7° 51′. With hydrochloric acid, this licarene formed a liquid hydrochlorate, $C_{10}H_{18}Cl_2$, and with bromine a tetrabromide, melting at 103° to 104°. The nitroso-chloride of the hydrocarbon yielded, upon boiling with alcoholic potash, nitroso-limonene, with a melting point of 72°. Licarene would thus be identical with dextro-limonene. But from the weak optical rotation of licarene, it is to be inferred that this substance is a mixture of a little limonene with dipentene and terpinene*. Heating with

* Schimmel, Bericht., Oct., 1893. These researches are also abstracted in Pharm. Journ. [3], xxiv., p. 82.

acetic anhydride further resulted in the formation of the acetate of an isomeric alcohol ($C_{10}H_{18}O$), to which the name *licarhodol* was given. This product, having a strong odour of roses, yielded upon oxidation the same aldehyde as licareol, $C_{10}H_{16}O$, and is, according to Barbier's view, the stable, stereo-isomeric form of licareol. According to Bouchardat,* licarhodol is identical with geraniol, which he has prepared in a similar manner from the linalöol of the oil of *Lavandula spica*. The properties of licareol and its derivatives leave no room for doubt that licareol is identical with linalöol, which occurs as an important constituent, not only in lign-aloe oil, but also in lavender oil and bergamot oil. Barbier has also investigated Coriander oil,† with the result that he has found coriandrol to be simply the dextrogyre form of licareol, or, in other words, dextro-linalöol, with a boiling point of 196° to 198° and an optical rotation of + 15° 1′. By oxidation he obtained the aldehyde $C_{10}H_{16}O$ (licareol) and the acid $C_{10}H_{16}O_2$ (licarenic acid) ; with chlorine water, the liquid chloride $C_{10}H_{18}Cl$. Dextro-limonene and the acetic ester of licarhodol were obtained through the action of acetic anhydride. Coriandrol, therefore, differs from licareol (linalöol) only in its optical rotation.

As regards *Rhodinol*, Barbier finds‡ that this isomer of geraniol stands in a similar relation to licareol, but it yields valerianic acid by oxidation. The evidence regarding its constitution points, as in the case of licareol, to the existence of two stereo-isomers, one stable and the other the reverse, the unstable compound being transformable into the first after heating with acetic anhydride. Rhodinol submitted to this treatment formed only *rhodinol-acetic ether*, a colourless, mobile liquid of agreeable odour, boiling at 131°. On saponification, unaltered rhodinol was re-formed from this ether. The alcohol appears, therefore, to constitute the stable modification corresponding to an as yet unknown unstable one capable of conversion into the former on treatment with acetic anhydride.

* Comptes Rendus, cxvi., p. 1253.

† Comptes Rendus, cxvi., p. 1459.

‡ Comptes Rendus, cxvii., p. 177.

VOL. I., P. 77.

Bergamot. The most important constituent of Bergamot oil, amounting to 40 per cent., has (as mentioned in Vol. I., p. 77) been found to be *Linalyl-acetate*, (Linalöol-acetate), the acetic-ester of Linalöol, a liquid which is also contained in oil of lavender (see above). This ester being the real vehicle of the bergamot aroma, the quantitative estimation of it in a bergamot oil directly indicates the value of the sample.* Messrs. Schimmel & Co. state in a recent report† their opinion of this method of evaluation, and give the results of their experiments on various specimens of oil as follows :—

"Supported by the results of numerous observations, we are now in a position to lay down exactly the requirements for a genuine Bergamot oil. *The value of a sample may be accurately judged by the determination of its physical properties and the proportion of linalöol-acetate which it contains.*

"The chief adulterants of Bergamot are oil of turpentine, oil of orange and oil of lemon.‡ All three affect the solubility of the Bergamot oil in diluted alcohol, and reduce its specific gravity and the percentage of ester. In examining Bergamot oil it is therefore first of all necessary to ascertain the specific gravity and specific rotatory power. *It should be soluble at 20° C. in 1½ to 2 volumes 80 per cent. alcohol*; slight turbidity, which becomes greater upon the addition of more alcohol, is caused by the separation of Bergaptene, *but no small drops of oil should remain undissolved.*

"To distil the oil under ordinary atmospheric pressure, is quite useless for the purpose of determining the value, as under such conditions a radical decomposition of the oil supervenes.

"The following tables contain, besides physical data, the results obtained in an ester-determination of Bergamot oils of different quality :—

* Compare the researches of Semmler and Tiemann, Ber. Deutsche. Chem. Ges., xxv., p. 1180.

† Bericht., April, 1893.

‡ For other adulterants see p. 76, vol. i.

TABLE I.—*Good and medium oils.**

NO.	ORIGIN.	SP. GR. AT 15° C.	SPECIFIC ROTARY POWER (20 M.M.)		SAPONIFICATION QUANTITY.	SAPONIFICATION KOH used.	ESTER PROPORTION.
1	Own distillate 1893 ...	0·895	Undetermined†	All soluble in 1½ to 2 Vols of 80 % alcohol.	2·50 g.	0·3248 g	45 %
2	Reggio, S. ...	0·886	+ 3°		2·18 „	0·2520 „	40·5 „
3	„ „ ...	0·886	+ 3°10′		2·33 „	0·2632 „	39 „
4	„ „ ...	0·884	+ 2°		2·20 „	0·2464 „	39·1 „
5	„ „ ...	0·886	+ 4		2·37 „	0·2632 „	38·99 „
6	„ „ ...	0·884	+ 2		2·05 „	0·2184 „	37 „
7	„ „ ...	0·883	+ 2		2·785 „	0·2912 „	36·6 „
8	Messina, J....	0·883	+ 2		2·555 „	0·2632 „	36·3 „

* Helbing and Passmore have recently, in close agreement with the above figures, ascertained the ester proportion of 42·4% in a Bergamot oil examined by them. Pharm Rec., Jan., 1893.

† Owing to the dark colour of this sample, its specific rotatory power could not be ascertained.

TABLE II.—*Inferior and bad oils.*

NO.	ORIGIN.	SP. GR. AT 15°C.	SPECIFIC ROTATORY POWER (20 M.M.)	SOLUBILITY IN 1½ TO 2 VOLS OF 80% ALCOHOL.	SAPONIFICATION. QUANTITY.	SAPONIFICATION. KOH used.	ESTER PROPORTION.
1	Messina, P.	0·881	+ 3°20′	not sol.	2·98 g.	0·2968 g	34·8 %
2	„ R.	0·881	+ 3°	soluble	1·95 „	0·1848 „	32·9 „
3	„ J.	0·880	+ 3°	not sol.	1·74 „	0·1568 „	31·4 „
4	„ R.	0·878	+ 5°20′	„	2·63 „	0·2352 „	31·2 „
5	„ K.	0·875	+ 3°	„	2·41 „	0·1512 „	22·0 „

TABLE III.—*Mixtures made by us (for purposes of control) from good oil with*

No.	Added.	Sp. Gr. at 15°C.	Specific Rotatory Power (20 m.m.)	Solubility in $1\frac{1}{2}$ to 2 vols. of 80 % Alcohol.	Saponification. Quantity.	Saponification. K O H used.	Ester Proportion.
1	24·3 % Turpentine oil	0·879	+ 2°	not sol.	2·97 g.	0·2240g	26·3 %
2	25 % Orange oil ...	0·876	+ 6°	„	3·21 „	0·2576 „	28 „
3	25 % Lemon oil ...	0·879	+ 4°40′	„	2·43 „	0·2184 „	31·3 „

TABLE IV.—*Distilled oils.*

No.	Origin.	Sp. Gr. at 15°C.	Specific Rotatory Power. (100 m.m.)	Solubility in $1\frac{1}{2}$ to 2 vols. of 80 % Alcohol.	Saponification. Quantity.	Saponification. K O H used.	Ester Proportion.
1	From the residue of our 1893 pressing...	0·873	+11°10′	soluble	7·26 g.	0·2576g	12·4 %
2	From the residue of our 1892 pressing...	0·873	+4°	„	4·23 „	0·1456 „	12 „
3	Oil of 40 % Ester rectified ...	0·871	+20°40′	„	2·41 „	0·1512 „	22 „

Commenting on the results above tabulated, the investigators remark as follows :—

"The two first oils (on Table I.) prove that all oils of high ester-proportion distinguish themselves from the varieties containing less ester by their higher specific gravity and their greater solubility in 80 % alcohol. Our own pressing (Table I. No. 1) contains a higher ester percentage and a higher specific gravity than all other oils at present known to us, even from the best sources. *It is probable that an entirely unmixed Bergamot oil is never seen in commerce.*

"The third table shows, by means of the control experiments, that the addition of Turpentine, Orange oil or Lemon oil, can be proved convincingly by the determination of the ester percentage.

"As the intensity of the aroma and therefore the value of Bergamot oil depend solely upon the quantity of Linalöol-acetate which it contains, we must consider the determination of the ester percentage to be the *decisive* test of quality, and may fix the minimum at 38 *per cent. of Linaöol-acetate.* The sp. gr. should not be below 0·881 at 15° C. nor the specific rotation higher than 20° (100 m. m.). These requirements, as shown by Table I., are very moderate, and will soon have to be made more severe, in the interests of genuine manufacture.

"Table III. explains the changes which Bergamot oil experiences by steam-distillation. The abnormally low ester-percentage of the oils distilled from the residue of the pressing, or of the rectified oils, shows that *all distilling operations are injurious.* In practice this has long been admitted, otherwise the much easier process of distilling the oil instead of pressing it by hand would certainly have been preferred. Owing to its poverty in ester the distilled oil only possesses a very slight Bergamot aroma and much more resembles in fact, Lign-aloe oil; also its specific gravity and behaviour towards acetic anhydride show it to be rich in Linalöol.

A distilled oil which only contained 12 per cent. of ester, showed, after treatment with acetic anhydride (as above-explained, on Lavender oil), a proportion of 61·5 per cent. of Linalöol-acetate. Pressed Bergamot oil also contains a little free Linalöol: an oil of 37 per cent. contained after this treatment, 47 per cent. of ester.

It may be taken for granted that the Bergamot oil manufacturers use the oil distilled from the residue of the pressing, to mix with the pressed oil. This is the explanation of the low ester percentage and the low specific gravity of the commercial oils as compared with the oil pressed by us.

The rectification of Bergamot oil must be pronounced altogether irrational. The acetate of Linalöol is such a delicate body, that it is already partly decomposed by steam distillation. As is proved by Table IV., No. 3, *a rectified oil is worth intrinsically about half as much as a pressed oil.* To go to the trouble of rectifying the oil is therefore surely paying too high a price for the mere optical advantage of absence of colour."

In the Report from which the above valuable information is abstracted, the authors take the opportunity of making the following preliminary statement concerning a scientific investigation which they have undertaken, and which may possibly lead to important practical results:—"A series of recent researches has established the fact that the Esters of certain alcohols of the composition $C_{10}H_{18}O$, and $C_{10}H_{20}O$, are principal constituents of a large number of essential oils, which owe their aroma in the main to the presence of the esters in question.

"Thus, for instance, Linalyl-acetate and other esters of Linalöol have been recognised as constituents of Lavender oil, Bergamot oil and Petit-grain oil; while Geranium oil, Lavender oil and Lemon-grass oil contain esters of Geraniol, principally geranyl-acetate. In Pine oils, finally, esters of Borneol have been found. In the course of this investigation we have succeeded in discovering a new process for the isolation of these esters, for which we have applied for a Patent. All these esters are very sensitive bodies which cannot be distilled under ordinary atmospheric pressure without splitting up: to obtain them free from foreign bodies, distillation in vacuo is therefore necessary. Up to the present we have succeeded in preparing over twenty such esters, several of which appear to possess a practical value. Amongst them are:—

Bornyl-acetate (crystallised in rhombic crystals). Boiling point 98° C. at 10 m. m., sp. gr. 0·991 at 15° C. Melting point 29°. Has an intense odour of Fir-needles.

Bornyl-formiate (liquid). Boiling point 90° at 10 m. m., sp. gr. 1·013 at 15°. Aroma resembling that of Bornyl-acetate.

Geranyl-formiate (liquid). Boiling point 104°-105° at 10 m. m. Has a strong, pleasant aroma of a peculiar character.

Geranyl-acetate (liquid). Boiling point 111°-115° at 10 m. m. Aroma resembling that of Lavender oil, but more agreeable.

Linalyl-formiate (liquid). Boiling point 100°-103° at 10 m. m. Aroma resembling Petit-grain oil and Bergamot oil.

Linalyl-acetate (liquid). Boiling point 108°-110° at 10 m. m. This ester possesses a strong Bergamot odour and will doubtless be very useful. We have prepared a large quantity of this article, which we bring into commerce under the name of *Bergamiol.*"

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Bergapten. The chemical constitution of this crystalline constituent of Bergamot oil is represented by the formula $C_{12} H_8 O_2$. It has recently been investigated scientifically by Pommeranz.*

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Lemon oil. As turpentine oil is the main adulterant of Lemon oil, of which it lowers the specific rotatory power considerably, while on the other hand it increases the specific gravity, the determination of these two points becomes of great importance. The rotatory power of a good pure Lemon oil should not be below + 60° in a 100 m.m. column, and the sp. gr. should be from 0·858 to 0·859 at 15° C. If these tests are applied with due care, adulteration by turpentine oil cannot pass undetected..

Other probable adulterants of Lemon oil are the terpenes (a mixture of Pinene and Limonene), which are abstracted from Lemon oil in the manufacture of the so-called "Terpene-free Lemon oil," or concentrated Lemon oil. These terpenes, although of a lemon-like odour, contain practically no Citral, the odoriferous principle of oil of lemon. It is stated that a firm of manufacturers of the "Terpeneless Lemon oil" is doing a considerable trade in such terpenes, invoicing the same under the denomination of "Citrene." As "citrene" is not to be found in price-lists the inference is that it is used to cheapen Lemon oil. What is now required to check this manipulation is a process for the quantitative determination of the citral percentage in Lemon oil. Efforts are being made to

* Monatsheft für Chemie, 1893, p. 28.

devise such a process, the value of the oil depending exclusively upon the proportion of citral present in it. Although the aroma of citral appears (in consequence of its enormous concentration) to vary somewhat from that of Lemon oil, it will be found, on diluting it to its corresponding strength, that there is no longer any difference between it and Lemon oil, either in odour or in taste. The action of concentrated sulphuric acid on "citrene" has been studied by Bouchardat and Lafont.*

It is greatly to the interest of consumers to secure the oils which are *prepared during the first two months of the harvest*, *i.e.*, November and December, experience having shown that the first oils of the season are of a better quality than those obtained from later-matured fruit. Also the fruit itself which is gathered in November and December is preferred in commerce to that which is collected later on.

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Orange oil, sweet. As this oil consists chiefly of the strongly dextrogyre limonenes, and the adulterations are chiefly practised with turpentine oil, the method of examination in this case also is based upon the determination of the two important physical properties—specific rotatory power and specific gravity. The rotatory power of pure oils has been determined as $+ 97°20'$ or at least $+ 95°$ in a 100 m. m. tube, and their sp. gr. 0·850 at 15° C. If turpentine be added to such an oil the rotatory power will naturally decline and the sp. gr. increase. Thus, an examination being made of a suspected sample, the specific rotatory power was found to be $+ 65°20'$, and the sp. gr. at 15° C. 0·856, data which indicated gross adulteration with turpentine; in confirmation of this, the turpentine was separated out and identified. During the distillation 50 per cent. of the oil came over below 170°, that is to say, much below the boiling point of Limonene, the chief ingredient of genuine oils. By repeated fractional distillation a considerable quantity of almost pure Pinene was recovered from the oil. It possessed the following properties:—

Boiling point	158°-162° C.
Specific gravity	0·861 at 15° C.
„ rotatory power......	$+ 6°40'$ (100 m. m.)

* Journ. de Pharm., xxvii. (1893), p. 49.

and was further characterised by the derivative Pinene-nitrobenzylamine of 122°-123° C. melting point.

In genuine orange oil, natural Pinene only occurs in exceedingly small quantities; this is evident from the extent of dextro-rotation, which almost equals that of pure limonene. Having regard to the low specific rotatory power of the oil examined, it may be taken for granted that this specimen consisted of a mixture of orange oil with at least 20 per cent. of turpentine oil.

There exists, however, a more dangerous adulterant, viz., the so-called "Aurancine," the residual product in the manufacture of "concentrated" orange oils.

The total exports of Sicilian and Calabrian essential oils in 1892 were as follows :—

Exports from	Messina	264,101	Kilos.
,,	Reggio	54,000	,,
,,	Catania	5,401	,,
,,	Palermo	35,876	,,
	Total...	359,378	,,
The total in	1891 was	264,150	,,
,,	1890 ,,	301,879	,,
,,	1889 ,,	277,599	,,
,,	1888 ,,	298,611	,,
,,	1887 ,,	336,128	,,

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Camphor. Consular Report (No. 1,260) states that "the average annual export of camphor from Japan is about 5,000,000 lbs., of which about one quarter reaches the United States, either direct or *viâ* Europe: the remainder being taken by Europe, excepting a small quantity sent to India. In 1892, the total purchases by foreign dealers amounted to 1,713 tons, which is below the business of an average year. Prices ruled in favour of Japanese producers: the lowest having been 35 dollars per picul of 133½ lbs. in May, and the highest, 63 dollars in December. These figures represent common crude camphor, which, during the year has been doctored and adulterated worse than ever, in spite

of high values paid and the strong protests of purchasers, some of whom now absolutely refuse to have dealings in camphor which has not drained in the warehouses during at least 48 hours." The Report adds :—" The districts in Japan famed for camphor trees are Kiushiu, Shikoku, Iga, Suruga, Isé and Kishiu. The forests owned by the people are now almost denuded of timber and very little will be left a few years hence. However, the Government forests are still very rich in camphor trees, and it has been estimated that these alone will maintain annually during the next twenty-five years the full average supply of crude camphor. Formerly, very little care was bestowed upon the preservation and cultivation of this valuable timber. More recently, however, not only the Government, but also the people, have been giving to this most important question the attention it long ago deserved. Numerous young trees have now been planted and their growth is being carefully tended. Consequently, although hitherto the youngest wood from which camphor was extracted was about seventy or eighty years old, it is expected that under present scientific management, the trees will give equally good results after twenty-five or thirty years. The roots contain a much larger proportion of camphor than the trees, 10 lbs. of crude camphor out of 200 lbs. of wood-chips being thought satisfactory. The Suruga timber yields a much smaller percentage."

Pine-needle oil. Under the general name of Pine-needle oil (in German "*Fichtennadelöle*") are comprised the volatile oils of the needles and young shoots of various conifers belonging to the genera *Pinus*, *Picea*, *Abies* and *Larix*. Our knowledge of the chemistry of these oils is still imperfect; with some few exceptions there have been no complete investigations of them, and it has hitherto been customary to consider only certain of their physical characters, such as specific gravity, optical rotation, boiling point, and the detection of particular terpenes. For distinguishing between the needle oils and turpentine oils, the odour has been the chief criterion, and only in a few instances determination of the rotatory power afforded the means of ascertaining the presence of considerable amounts of laevolimonene in some kinds of pine-needle oil. Under these circumstances it is not remarkable that the material met with in commerce as " pine-needle oil " has often

been nothing more than turpentine oil, to which a pine-needle odour has been communicated by distillation over coniferous needles, or by an admixture of some true pine-needle oil. A practical examination of genuine pine-needle oil was therefore desirable, and, operating upon material of unquestionable origin, Bertram and Walbaum have determined the physical characters and constituents of several of these oils, so far as the present state of science will allow. The details of the investigation have been published in the "Archives der Pharmacie," 1893, p. 270-305.*

It has been ascertained that in almost all kinds of pine-needle oils esters of borneol are present, chiefly the acetic ester, and this may be regarded as the body to which the peculiar pine odour is due. The value of the oil is estimated by the quantity of this body present. The particular character of these oils is determined also by the presence of different terpenes. Among these have been found lævopinene, dextropinene, lævolimonene, dipentene, phellandrene and sylvestrene. Most of the oils also contain the sesquiterpene named by Wallach *cadinene*.

To estimate the value of pine oils, it is necessary, not only to ascertain the specific gravity, the optical rotation and the boiling point, but also to determine the percentage of esters (Bornyl acetate). The quantitative ester-determination may be carried out in the ordinary way by the saponification of the oil with an alcoholic potash lye of known strength and subsequent titration with an acid. The percentage of bornyl acetate is calculated from the quantity of potash in combination.

The oil of *Abies pectinata*, D. C. (*A. excelsa*, Lk.) is extracted in Switzerland and the Tyrol from the needles and young shoots of this pine (Norway Spruce Fir). It has a very agreeable fresh odour, and is therefore largely used as a perfume. The oil has a sp. gr. of 0·875 at 15° C., and is lævo-rotatory for a column of 100 m.m. —20° 40′.

Distilled under ordinary pressure, 8 per cent. passes over between 150° and 170° C., and 55 per cent. between 170° and 185°: decomposition then commences, as the bornyl acetate present can only be distilled in vacuo or by the aid of steam.

Naturally, the boiling point of an oil liable to undergo decompo-

* Abstracted in Pharm. Journ. [3], xxiii., p. 967; and Journ. Chem. Soc., Nov., 1893.

sition by heat cannot give any indication of its composition. In this instance, the liberated acetic acid converts part of the terpene into dipentene, terpinene and polymeric products, by which the boiling point is raised. A determination of the boiling point serves, however, to distinguish genuine oil from those kinds which consist chiefly of turpentine oil, and therefore distil over completely below 170° C.

To ascertain the nature of the constituents of this oil, it was heated for some hours with a sufficient quantity of alcoholic potash, and then fractionated by means of steam :—From the lowest boiling fraction, frequently rectified over sodium, pinene was obtained, boiling at 157°-160°, optical rotation —32°. Refraction for the line n_D 1·4658. For further identification, it was converted into very characteristic nitrosochloride and nitrolbenzylamine compounds.

The fraction boiling from 170° to 180° was lævo-rotatory, and when bromated gave a large quantity of limonene tetrabromide, showing the presence of lævolimonene.

From the fraction of higher boiling point (190°-240°) crystals were deposited on cooling, which melted at 206°-207° after recrystallisation from petroleum spirit, and had all the characters of lævo-borneol. The portion boiling above 240° consisted almost entirely of sesquiterpene. The acid separated by saponification consisted chiefly of acetic acid, and the amount of bornyl acetate was found to be 4·5 per cent.

Operating in a similar manner with samples of other oils, the following results were obtained :—

The oil produced in Switzerland and in Thuringia from the young cones of *Abies pectinata*, D.C. (*Abies excelsa*, Lk.) is also met with in commerce under the name of pine needle oil. It differs from the oil above referred to (from the needles and young shoots) in its mild odour, low specific gravity and greater rotatory power. The Swiss oil examined by Bertram and Walbaum had a sp. gr. of 0·854, rotation —72°. Between 150° and 170° 16 per cent. distilled over, from 170° to 185° 76 per cent., and the residue amounted to 8 per cent. The amount of ester in this oil was so small* that the separation of borneol was not attempted. The chief constituents are lævo-pinene and lævo-limonene, the latter pre-

* About 0·5 per cent.

dominating and amounting to a very high percentage. In accordance with this fact, its sp. gr. is very low and its optical rotation very high; in commercial samples (sold as "superfine oil of pine needles"), the sp. gr. has been observed to be from 0·853 to 0·862 and its rotatory power —57° to —75°.

The oil obtained from the needles and young twigs of *Abies Canadensis*, Lin. (Hemlock Spruce Fir), in North America was found to have a sp. gr. of 0·907 at 15° C., and an optical rotation of —20° 54′. It contains lævo-pinene, sesquiterpine and as much as 36 per cent. of lævo-bornyl acetate. Oil prepared by the investigators from fresh needles and branches of *Picea vulgaris*, Lk., had a sp. gr. of 0·888 and an optical rotation of —21° 40′. It contained lævo-pinene, lævo-phellandrene, dipentene, lævo-bornyl acetate (8·3 per cent.) and sesquiterpene. In the Austrian Alps, the needles and branches of *Pinus Pumilio*, Haenke (Mountain Pine), are distilled on a large scale, and the oil obtained from them is extensively used in soap-making and other purposes of perfumery. A sample of this oil from the Pustesthal of sp. gr. 0·865 and —9° rotation was found to contain lævo-pinene, lævo-phellandrene, sylvestrene, bornyl acetate (5 per cent.) and a little sesquiterpene.

The oil produced in Sweden from the needles of *Pinus sylvestris*, Lin. (Scotch Fir), was found to have a sp. gr. of 0·872 and a rotation + 10° 40′, and to contain dextro-pinene, sylvestrene and probably some bornyl acetate; 44 per cent. distilled at 160°-170°. and 40 per cent at 170°-185°. The oil obtained from the needles of this tree, growing in Germany, had a sp. gr. of 0·886 and a rotation + 10°. Its composition was similar to that of the Swedish oil.

The occurrence of sylvestrene in the oils of *Pinus pumilio* and *Pinus sylvestris* is interesting, as this terpene has hitherto been noticed only in Swedish and Polish oils of turpentine. Its presence in the Pine oils was proved beyond doubt by the formation of the typical hydrochlorate of 72° melting point.*

The oil of *Pinus picea* (Silver Fir) is very similar in character to the true Pine oil (from *Picea vulgaris*). Its sp. gr. is 0·875 and its optical rotation —58° 40′.

Hirschsohn† has recently discovered bornyl-acetate in Siberian Pine oil (from *Abies Sibirica*) and isolated it.

* Schimmel & Co., Bericht, April, 1893.

† Pharm. Zeitschrift für Russland, 1892, No. 38.

Flawitzky* examined oil of *Pinus Cembra*, Lin., and prepared from it by repeated fractional distillation, a terpene of sp. gr. 0·861 at 18° C., and an optical rotation of +38°·74 (100 m. m. tube). By conversion into the hydrochlorate, melting at 125°, it was ascertained to be dextro-pinene (he calls it dextro-terpene). Pure pine oil only yields a small quantity of a constituent (Lævo-pinene) boiling below 170° and leaves a considerable residue in the retort boiling above 185°, which consists mostly of bornyl acetate and other esters of bornyl; but as before observed, decomposition commences at a temperature over 185°, and the bornyl acetate present can only be distilled in vacuo or by the aid of steam. (Bornyl acetate boils at 98° at 10 m. m.). Besides this body, lævo-limonene must also be considered as an important constituent in pine oil.

Even a simple distillation from a fractionating flask affords a view of the differences between the coniferous oils coming into commerce, as the following table shows :—

PURE PINE OILS.

ORIGIN.†	FRACTION 150°–170°	FRACTION 170°–185°	RESIDUE.
Pinus Vulgaris, Lk.... Sp. gr. 0·933 Rotation —23°	17 per cent.	33 per cent.	50 per cent
Pinus Picea ... Sp. gr. 0·875 Rotation —58° 40′	8 ,,	55 ,, containing limonene	containing borneol. 37 ,,
Abies Canadensis, Lk. Sp. gr. 0·907. Rotation —20° 54′	11 ,,	37 per cent.	52 ,,
Pinus pumilio, Haenke Sp. gr. 0·865 Rotation —9°	nil.	70 ,,	30 ,,
Abies Excelsa, Lin. (from the Cones) ... Sp. gr. 0·854 Rotation —72° 40′	16 per cent.	76 ,, containing limonene	8 ,, (no borneol)

* Journ. für Pract. Chem., xlv., p. 115.

† Sp. gr. is taken at 15° C. and at 100 m.m. pressure The optical rotation was observed in 100 m.m. tube.

Cheap Commercial Oils.

No.	Physical Properties.	Fraction 150°–170°.	Fraction 170°–185°.	Residue.
1	Optical rotation + 14°	96 per cent. turpentine oil	1 per cent.	3 per cent
2	Sp.gr. 0·873 at 15°C. Opt. rotation + 4°	95 per cent. turpentine oil	1 "	4 "
3	Sp. gr. 0·868 Optically inactive	100 per cent turpentine oil: the first runnings were acetic ether	—	—

It is thought probable that besides borneol, other alcoholic constituents may be present in some of the pine-needle oils, for while in some instances it is easy to obtain borneol in a crystalline state after saponification in quantity almost corresponding to the amount of ester, in others it cannot be isolated at all, or only in small proportion.

On account of the interest attaching to bornyl-acetate, Messrs. Bertram & Walbaum have prepared the ester artificially from both lævo, and dextro-borneol. The lævo-bornyl acetate corresponds in all its characters with the natural ester.* The dextro-acetate is distinguishable only by the rotatory power. In a pure state bornyl acetate melts at 29° C., and it crystallises from petroleum spirit in rhombic crystals often an inch long. The borneol esters of acids homologous with acetic acid, are very much like the acetate in odour, but it intensely increases with the molecule of the acid constituent. It is probable that one or other of these esters may be present in pine-needle oil, together with bornyl acetate.

* Series i., p. 342.

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Benzoin. According to observations made in Java by Tschirch, "the trees yielding benzoin have no secretory receptacles, and do not contain any secretion, the leaves, flowers, bark and wood being entirely free from odour; and it is only when the plant is wounded that the odoriferous benzoin exudes, consequently it must be regarded altogether as a pathogenic product."* Fritz Ludy has endeavoured to ascertain the substance which gives rise in this way to the formation of Benzoin,† the material for that purpose having been supplied by Professor Tschirch.

By treatment with ether, Siam Benzoin, like the Sumatra variety, is almost completely dissolved, the residue amounting to only 1·6 to 3·3 per cent. On shaking the ether solution with dilute alkali solution, it suddenly solidified to a gelatinous mass of crystals, from which the ether could not be separated. Upon adding some alcohol, crystals of potassium salt of benzoresinol were deposited after some hours. By using a very dilute alkaline solution, and leaving it for some in contact with the ether solution of benzoin, without shaking, a sharp separation of the two liquids was effected. The dark-coloured watery liquid was drawn off, and the ether solution repeatedly washed with very dilute caustic alkali. By treatment of this ether solution with sodium sulphite, no evidence of the presence of aldehydes was obtained. On distillation of the ether a yellowish thick liquid of very aromatic odour remained, amounting to about 0·3 per cent. of the benzoin, and probably consisting of a benzoic ester, the alcoholic constituent of which was not ascertained. In this way it was found that styrol, benzaldehyde, benzene, styracin and phenyl-propyl cinnamic ester ($C_{18} H_{18} O_2$), which are constituents of Sumatra benzoin, are not present in Siam benzoin. The alkaline liquor contained benzoic acid, vanillin amounting to 0·15 per cent. of the benzoin, and a resinous substance which gave no benzaldehyde when warmed with permanganate, but resembled the product obtained from Sumatra benzoin. This was found to consist of benzoresinol and siaresinotannol—a substance analogous to resinotannol. *Benzoresinol*, $C_{16} H_{26} O_2$, from Siam benzoin, is a white amorphous substance, without taste or odour, melting at

* Pharm. Journ. [3], xxiii., p. 886.

† Archiv. der Pharm., xliii., p. 231.

272°, and presenting characters which show that it is identical with the product from Sumatra benzoin. *Siaresinotannol*, $C_{12}H_{14}O_3$, is also an alcohol having the form of a brown powder free from taste and smell, differing in composition from resinotannol of Sumatra benzoin, but analogous to it in most of its characters.* The general result of these observations is that both Sumatra and Siam benzoin consist chiefly of mixtures of benzoic esters of resinoid alcohols, together with 1·6 per cent. free benzoic acid and some vanillin.

The bark of Styrax Benzoin, Dryander, contains, besides traces of wax, some phloroglucin and sugar, a large amount of tannin. which is readily convertible by oxydation into its *phlobaphen*, corresponding with the formula $C_{51}H_{50}O_{21}$, and Ludy is of opinion that this is the source from which benzoin is produced.

Vol. I., p. 352.

Cajuput. *Malaleuca viridifolia.* This myrtaceous tree has been found growing in great abundance in New Caledonia. Its leaves, when fresh, yield on distillation with water, about 2·5 per cent. of their weight of a pale yellow oil, known as "*Essence de Niaouli*," of which the odour recalls that of cajuput. This oil has been examined by G. Bertrand, who describes it† as having a density of 0·922, and a rotatory power of + 0° 42′. By adding to it successively solutions of potash and of sodium bisulphite, and resorting to saponification, the presence of a trace of valerianic acid was indicated, as well as small proportions of benzoic aldehyde and valerianic ether. On distilling, four-fifths of the oil pass over below 180°, which may be divided into two fractions, one of which boils at 155°-156°, and the other at 173°-175°. The first is a terpene, having, after distillation with sodium, a density of 0·865 and rotatory power + 36°·03′. Its formula is $C_{10}H_{16}$, and with hydrochloric acid gas it forms a crystalline monochlorhydrate, having, in alcoholic solution, a rotatory power of + 25°·09′. The second fraction is a mixture from which, at a temperature below

* Siaresinotannol yields a potassium derivative, $C_{12}H_{13}O_3K + H_2O$, crystallising in yellow needles, and an acetyl derivative, $C_{12}H_{13}AcO_3$, as a yellow amorphous powder.

† Comptes Rendus, cxvi., p. 1070.

—6°, a crystalline mass can be separated. The purified crystals appear to consist of eucalyptol. They melt at 1° to a liquid of camphoraceous odour, optically inactive and boiling at 175°. The sp. gr. of this eucalyptol is 0·930 and its vapour density 5·28 (calculated 5·34 for $C_{10} H_{18} O$). Treated with very dry hydrochloric acid vapour, an unstable crystalline compound is formed, having the composition $(C_{18} H_{18} O)_2$ H Cl. Water instantly decomposes this into its original components. The liquid from which the crystals have been separated has a lemon odour, and is apparently a mixture of eucalyptol and a hydrocarbon of the formula $C_{10} H_{16}$. Its density is 0·917, and optical activity —4°10′. The fraction distilling above 180° forms a syrupy liquid, boiling about 220°, and yielding a small proportion of crystals at —50°. By using one of these crystals as the starting point, crystallisation may afterwards be readily induced in the remaining liquid, taking place rapidly at the ordinary temperature. The solid substance, dried *in vacuo*, only melts when a temperature of about 30° is attained, the syrupy liquid then formed having the formula, $C_{10} H_{18} O$, boiling at 218°, and presenting all the characteristics assigned by Bouchardat and Lafont to the terpineol synthesised by them*, except that it is feebly lævo-rotatory, —2°10′, whilst the synthetic terpineol was inactive. Finally, there remains in the apparatus after distillation a small quantity of resinified matter of a greenish colour.

Neglecting the secondary products, Bertrand arrives at the conclusion that the essential oil of *M. viridifolia* consists, apart from the dextro-rotatory terpene, $C_{10} H_{16}$, a mixture of three bodies, eucalyptol, a hydrocarbon, probably "citrene" (*sic*), boiling at 175°, and a terpineol. This composition is identical with that of the terpinol of List,† obtained by heating with acidulated water the terpene $C_{10} H_{16}\ 2 H_2 O$, resulting from the spontaneous dehydration of terpenes, $C_{10} H_{16}$, the natural product being thus readily imitated artificially in the laboratory by extremely simple reactions.

Referring also to the fact that Bouchardat obtained a "citrene" by heating the valerylene derived from amylic alcohol, the author states that he has found it possible to extract small quantities of

* Comptes Rendus., cii., p. 1555.

† Comptes Rendus, civ., p. 996, and cvi., p. 663.

amylic alcohol from portions of the oil examined by him that passed over at about 130° when separating the terpene. He has found similar traces in the oils of cajuput and eucalyptus.

Vol. I., p. xvii.

Hedyosmum. In the "Introduction" to the 1st series, p. xvii., mention is made of a plant known in Jamaica as "Tobacco Bush," *Hedyosmum nutans,* Swartz.* The odour of the essential oil of

this shrub certainly reminds one of the fragrance of fine "honey-dew" cake tobacco blended with that of the best cake "cavendish" (odours which are due to "ferment oils"), but, at the same time, a careful observer will notice a trace of the odours of carvol and carvacrol, and an inexperienced person will compare the odour to that of "Old Brown Windsor soap." A sample of this oil was exhibited at the Colonial Exhibition in London, and, considering that the leaves can be had in quantity, it is surprising that manu-

* Flor. Occident., ii., p. 951; and Grisebach, Flor. of West Indian Islands, p. 173.

facturers of toilet soaps have overlooked the possible utility of this oil, and that, except as a museum specimen, the oil is unknown. The sample forwarded to the writer by the Government Chemist at Kingston (Jamaica) was too small for a thorough examination of its physical properties to be made, but its fragrance is of a peculiar nature to be remembered, and is certainly worthy the attention of manufacturers who produce "novelties." The complete botanical analysis of the plant can be found in the works of Swartz and Grisebach above quoted. The accompanying illustration is copied from the former writer, the scale being reduced. The leaves are from 3 to 5 inches long, other parts in proportion. The plant, as before observed, is common on the hills about Port Royal and on the Blue Mountains at elevations up to 6,000 feet.

It may be here remarked that Government Chemists, Directors of Botanical Gardens, Consuls, &c., are generally ready to supply information to enquirers on subjects which may be of commercial utility (in fact it is their function to do so), and persons who think of establishing themselves as planters in our Colonies would find it to their advantage to correspond with such functionaries before taking any decisive steps.

VOL. I., P. 307.

Coleus aromaticus, Benth., Flor. Brit. Ind., iv., p. 625.

Syn. *C. aromaticus*, Lour., and *Plectranthus aromaticus*, Roxb.

Vernacular. Páthor-chur, Hind.; Pater-chúr, Beng., Páthor-chur, Owa, Bomb.; Pásháua bhedi, Sans. In "Flora Andhirica," Karpura-valli is a name applied to this plant.

This perennial labiate plant is a native of the Moluccas, and is cultivated in gardens throughout India. The leaves and all parts of this plant are delightfully fragrant. The stem is creeping, round, succulent, perennial. Branches erect, round, very succulent, fragile, hairy, foom 1 to 2 feet high. Leaves opposite, short-petioled, very thick and fleshy, fragile, broad cordate, crenulate, 2 to 3 inches long and the same wide. The hairs on the upper surface are principally jointed and tapering, but a few are simple and surmounted by a globular, transparent, brilliant gland, like a minute dew-drop. On the under surface, the glandular hairs are

most numerous, and give rise to a frosted appearance. The epidermis is provided with numerous simple stomata. The venation is reticulate, and remarkably prominent on the under surface of the leaf. A few oil globules are met with in the parenchyma, but the aroma is chiefly situated in the glandular hairs. The flower spike is terminal, erect, long, verticelled, before the flowers expand imbricated with 4 rows of caducous bractes. Flowers numerous, blue. Perianth hairy, upper lip broad as in *Ocimum*, the lower lip long, projecting, concave. Filaments conjoined as in the diadelphous flowers, longer than the under lip, ascending, towards the apex distinct, the upper shortest.

VOL. I., P. 88.

Citronella oil. The shipments of this oil from Ceylon in 1892 were as follows :—

To the United Kingdom	6,952,152	ozs.
„ France	5,760	„
„ Germany	344,107	„
„ India	265,989	„
„ Australia	45,280	„
„ America	5,878,938	„
„ China	19,800	„
Total	13,512,026	ozs.

As compared with :—

In the year 1891	15,263,581	ozs.
„ „ 1890	14,599,078	„
„ „ 1889	10,263,433	„
„ „ 1888	10,550,465	„
„ „ 1887	8,828,578	„
„ „ 1886	6,745,794	„
„ „ 1885	6,570,139	„
„ „ 1884	4,997,333	„
„ „ 1883	3,916,398	„

VOL. I., PP. 104 and 106.

Violet and Orris. F. Tiemann and P. Krüger have endeavoured during ten years to isolate the chemical principle to

which the odour of the flowers of the violet and the rhizome of the orris, is due. (These observers being of opinion that the odorous principle developed in both plants is identical; an opinion which is most likely erroneous). They now state in a Memoir presented to the French Academy of Sciences,* that the odorous principle of orris root† is a Ketone $C_{13} H_{20} O$, which they name *Irone* and which may be isolated by the following process:—The extract obtained by exhausting the orris root with ether is distilled in a strong current of steam; the educt is a mixture consisting principally of

1—Myristic acid, oleic acid and other fatty acids.
2—The methylic ethers of those acids.
3—Traces of oleic aldehyde.
4—Neutral substances, in very minute quantity.
5—Irone.

This mixture is to be dissolved in alcohol, and an alcoholic solution of hydrate of potash then added to form potash salts of the free acids and to saponify the ethers. Water is then added, the neutral oils taken up with ether, and the residue distilled in a current of steam. The irone passes over with the first portions, and after repeated rectification a body is obtained, giving the characteristic reactions of a Ketone, but still containing small quantities of oleic aldehyde and other impurities, to free it from which it is heated with oxide of silver and water, and the separated crude irone transformed into its hydrazone by exposing it for several days to the action of phenyl-hydrazine in equimolecular proportions. The resulting mass is then distilled in a current of steam, to remove the excess of hydrazine and other impurities. Dilute sulphuric acid is added to the oily substance which remains in the retort, and pure irone passes over on distillation.

Irone is an oil freely soluble in alcohol, ether, chloroform, etc. Under a pressure of 16 m.m., it boils at 144° C. Its sp. gr. is 0·939 and its index of refraction $n_D = 1·50113$. It is dextrogyre, and forms a crystalline oxime which melts at 121°·5 and is transformed into the hydrocarbon *Irene* $C_{13} H_{18}$, when acted upon by

* Comptes Rendus, cxvii., p. 548, 23rd Oct., 1893.

† The raw material having been supplied to them by Laire et Cie. of Paris and Haarmann and Reimer of Holzminden.

hydriodic acid. The ultimate effect of oxidising agents upon irene is the production of ioniregene-triboxylic acid, $C_{12} H_{12} O_6$.

Experimenting with a view of obtaining Irone synthetically, Tiemann and Krüger state that an isomeric Ketone *Ionone*, $C_{13} H_{20} O$, having also a violet odour, can be obtained from Citral:—"The aldehyde (citral) is converted by the action of alkalies with acetone into a ketone $C_{13} H_{20} O$, *pseudo-ionone*, boiling at 143°-145° C., under a pressure of 12 m.m. Sp. gr. 0·9044, index of refraction n_D = 1·5275. This body has a peculiar and very characteristic odour. By the action of dilute acids it is converted into the isomeric ketone *Ionone*. Pure ionone agrees with the formula $C_{13} H_{20} O$, and under a pressure of 16 m. m. it boils at 126°-128° C.; its sp. gr. is 0·9351 and its index of refraction n_D = 1·507. By submitting it to the action of hydriodic acid at rather a high temperature, ionone loses the elements of water and yields a hydrocarbon, $C_{13} H_{18}$ *Ionene*. By careful oxidation (employing at first feeble reagents and gradually of successively greater strength, ionene is converted into ioniregene-triboxylic acid, which is identical with the product obtained by similarly oxidising the isomeric hydrocarbon Irene as above described.

Oil of Amber is a product of the dry distillation of amber.* Coarse pieces of amber are distilled in an iron retort, either alone or reduced to powder and mixed with sand. The crude product consists of a mixture of water, succinic acid and oil of amber. On standing it separates into three layers, the lowest consisting of water, the next containing the bulk of the succinic acid, whilst the upper layer contains the oil of amber. By drawing off the oil thus collected, it is obtained as a dirty brown, fluorescent liquid, possessing a nauseating odour. It is insoluble in water, but soluble in alcohol, ether, benzene, and many other solvents. The oil is scarcely acted upon by dilute mineral acids, but concentrated sulphuric and nitric acid re-act violently with it. By the action of nitric acid, much succinic acid is produced, and an orange-coloured resin possessing a strong odour of musk is produced, which is used as an "artificial musk." Reducing agents

* This paragraph should have been inserted in the Section on "Empyreumatic Oils."

have no effect on amber oil. Treatment with animal charcoal and other decolorising agents does not in the least improve the colour of the oil. On rectifying oil of amber, first water is obtained, then a yellow oil, followed by a green oil, and lastly a dark green oil. The temperature during distillation ranges between 150° and 360° C. A tarry matter remains behind, amounting to about 15 per cent. of the crude oil used. The distillates obtained still possess the repugnant odour of the original oil. Jolles says:—* "By carrying out the distillation, however, in a current of steam, almost odourless distillates are obtained. These distillates can be bleached by adding to them about 8 per cent. of permanganate of potash or bichromate of potash, together with the required quantity of dilute sulphuric acid. The oil is then left to separate from the water, the latter is drawn off, the oil completely dehydrated by addition of common salt or plaster of Paris, and then filtered. About 7 to 9 per cent. of the oil is lost in the bleaching."

The following processes have been recommended for preparing the **Artificial Musk**:—

1°—Oil of amber 1 fluid drachm; nitric acid 3½ fluid drachms. Digest in a cooled glass vessel, and after 24 hours wash in cold water the orange-yellow resinous matter which has formed and carefully dry it.

2°—Oil of amber 1 part, fuming nitric acid 3 parts, treatment as above, but employing artificial cold to prevent any portion of the oil being carbonised. Elsner proposed to call the artificial musk "Resin of Eupione of Amber."

* Ding. Polyt. Jnl.

SECTION V.

FLORAL ODOURS.

(CONTINUED FROM SERIES I.)

Rondeletia.

This name was given by Plumier in memory of William Rondelet, a famous physician and natural historian (Plumier, Nova plantarum Americanarum genera, p. 15, t. 12; Lam. ill., t. 162; Gærtner fil, Supplementum carpologiæ, t. 184), to an extensive West Indian and tropical American genus of the many-seeded division of *Cinchonaceæ*. Most of the species are shrubs, but a few grow to the size of trees. All the Asiatic plants referred to this genus are species of *Wendlandia*.

The perfume sold as "Rondeletia" takes its name from this plant, but is not really prepared from it, and is very inferior to the fine fragrance of the flowers of several of the species.

R. odorata is a shrub of 5 or 6 feet in height, native of Mexico and Havana, Cuba, being found on rocks by the sea-side. The flowers are in terminal corymbs, very sweet-scented, of a handsome scarlet colour, with the projecting ring of the tube orange-coloured. Jacquin, Stirpium Americanarum historia, p. 59, t. 42.

R. discolor, Humboldt, (Bompland and Kunth, Nova Plantarum, iii., p. 396, t. 291, is a shrub of 4 to 6 feet in height. Its flowers are pedicellate, fragrant, red on the outside: the lobes of the calyx are ovate-lanceolate. It is a native of New Granada, between Maraquita and Honda. Syn. *Hediotis discolor*, Sprengel, Systema Vegetabilium, i., p. 411.

R. disperma, Jacquin, is a tree of 15 feet in height, native of South America, frequent in rocky places in the woods of Cartagena, and very common in the islands of Baru and Tierra Bomba. The racemes are axillary, compound, loose, trifid. Flowers purplish-white, sweet-scented. It is considered that this plant may belong to a different genus, and may be a species of *Canthium*.

R. exserta, Roxb., Hort. Beng., p. 14; Syn. *Wendlandia exserta*, D.C., Prodr. iv., p. 41; also of Hooker and Thomson, Flor. Brit. Ind., iii., p. 37. A small crooked tree, 20 to 30 feet in height, with terete branches. The leaves are opposite, ovate-lanceolate, coriaceous, 4 to 9 inches in length by 1 to 3½ inches in width. The panicles are sessile and pyramidal. Flowers ⅙ inch diameter, sessile, white, fragrant. It is a native of the interior of Bengal, and has been noticed particularly over the ruins of the ancient city of Gour. It is found in dry forests of the tropical Himalaya, from the Chenab eastward to Nipal and Sikkim, ascending to 4,000 feet.

R. lucida, Wall., Cat. 8453. Syn., *Stylocoryne fragrans*, D.C., Prodr., iv., p. 377; *S. laxiflora*, Blume, Bijd., p. 983; *S. lucida*, Miquel; *Ceriscus fragrans*, Nees, Flora oder botanische Zeitung, 1825, p. 116; *Wahlenbergia fragrans*, Blume, Catalogus te Buitenzorg, 13; *Webera fragrans*, Blume, Bijd., p. 982, and Hooker and Thomson, Flor. Brit. Ind., iii., p. 103. This tree sometimes attains a height of 60 feet. Its branches are 4-angled; leaves elliptic, pale brown, 4 to 6 inches in length, narrowed into the petiole. It is a native of Malacca and Singapore, and is distributed in Java and Borneo. It is classed by modern botanists as a *Webera*.

Webera thyrsoidea.

Roth., Novæ plantarum species præsertim Ind. orient., p. 149: Syn., *Wendlandia Newtonia*, Wallich, W. & A. Prodr., p. 403; Wight, Icones, t. 1033: Beddome Flor. Sylv., t. 224; *Canthium thyrsoideum*, Rœmer & Schultes, Systema vegetabilium, vi., p. 207; *Ixora montana*, Miquel: *Cupia thyrsoidea*, D.C., Prodr., iv., p. 394. This shrub or small tree is found on the hills of the Deccan peninsula at altitudes of 2000 to 6000 feet. Its flowers are reddish white; very odorous.

Webera odorata, Roxb. Hort. Beng., 15; Flor. Ind., i., p. 699: Hooker & Thomson, Flor. Ind., iii., p. 102. Syn., *Pavetta Weberæfolia*, Br. in Wall. Cat., 6182 A.: *Cupia macrophylla*, De C., Prodr., iv., p. 394. This shrub is a native of Silhet, Assam, the Khasia Mountains, Muneypoor, Penang and Prince of Wales Island. Its

leaves are 5 to 9 inches long and 2 to 3 inches broad. The panicle is large, and the flowers large and white. *Rondeletia*, *Webera*, *Canthium*, *Wendlandia*, and *Cupia* are very nearly allied, and are generally very fragrant.

Cupia corymbosa.

D.C., Prodr., iv., p. 394, is a shrub of 5 or 6 feet in height, with lanceolate-oblong leaves 6 to 7 inches long and 2½ inches broad, shining, with revolute margins, and having hairy glands in the axils of the large veins. The corymbs are terminal; the flowers small, very numerous, at first white, but finally yellowish. The extremities of the young shoots are often found covered with a white resinous matter, like that on the germs of most species of Gardenia. It is a native of the Coromandel coast, Malabar, Pulo-Penang, on hills, Ceylon, China, &c. It is called by Rheede, *Cupi*, Rheede, Mal., ii., p. 37, t. 23. Syn., *Rondeletia Asiatica*, Lin. Spec., p. 244. *Webera corymbosa*, Willd., Spec., i., p. 1224; Bot. Reg., t. 126. *Canthium corymbosum*, Persoon, Synopsis plantarum, i., p. 200; Roxb. Flor. Ind., ii., p. 533. *Stylocoryna Webera*, Richard, in Mém. Soc. Hist. Nat., v., p. 248.

Cupia auriculata, D.C., Prodr., iv. p. 394. Syn., *Webera auriculata*, Wall., in Roxb Flor. Ind., ii., p. 537, is a large shrub, native of Pulo-Penang.

Cupia truncata, D.C., loc. cit., is a twining shrub with ovate leaves, 3 to 4 inches long, acute at the base, dark and shining above, coriaceous. The panicles are terminal. Flowers white, fragrant, on short pedicles, by threes or in fascicles. It is a native of Pulo-Penang, on hills. Syn., *Webera truncata*, Wall., in Roxb. Fl. Ind., ii., p. 538.

Cupia scandens, D.C., loc. cit., is a scandent shrub with glossy, oblong, acuminated leaves 6 inches long and 2 to 3 inches broad. The cymes are axillary. The flowers large, funnel-shaped, fragrant, white when they first open, but becoming yellow by the second day. Syn., *Webera scandens*, Roxb. Fl. Ind., ii., p. 534. Native of Silhet, where it is called *Gujer-Kota* by the natives.

Cupia cymosa, D.C., loc. cit., *Webera cymosa*, Willd., Spec., i., p. 1224; *Rondeletia cymosa*, Poiret, Dict. de Botanique, vi., p. 256;

Canthium cymosum, Persoon, Synopsis Plantarum, i., p. 200, is an arborescent shrub with pubescent branches and ovate-acute, shining leaves. The cymes are axillary, pedunculate, many-flowered. Flowers white, fragrant. Native of the East Indies.

Cupia thyrsoidea, D.C., loc. cit., ; *Webera thyrsoidea*, Roth., Novæ Plantarum, p. 149 : *Canthium thyrsoideum*, Rœmer et Schultes Systema Vegetabilium, vi., p. 207. A shrub with woody branches clothed with brown pubescence. Leaves oblong-ovate, acuminated at both ends ; thyrse dense, terminal ; flowers white.

Frangipani.

This name was given by French colonists in the West Indies, to the *Plumieria rubra* and *P. alba.*

Plumieria is the name of a genus of *Apocynaceæ*, having the corolla funnel-shaped, with a long slender tube, the segments of its border unequal ; and the style short, ending in a thick and notched stigma. The species are trees or shrubs, with alternate, fleshy leaves growing in tufts at the ends of the branches. The peduncles are terminal and corymbose. The plants are natives of Peru and other parts of South America and are distributed in several of the West Indian Islands. The genus was named by Tournefort in honour of Charles Plumier, a Franciscan traveller in South America and author of several excellent works on botany.

P. rubra, Jacquin, Stirpium Americanarum Historia (coloured plate edition), p. 35, t. 23 ; Lin. Hortus Cliffortianus, p. 76 ; Lin. spec., p. 306 ; Bot. Mag., t. 279 ; Catesby, The Nat. Hist. of Carolina, Florida, etc., ii., t. 92 ; Ehret Plantæ rariores, t. 10 ; Trew, Plantæ selectæ ab Ehret pictæ, t. 41 : Sloane, Voyage to Madeira, Barbadoes, Jamaica, etc., ii., p. 61 ; t. 185, f. 1 and t. 186, f. 1 ; Merian, De metamorphosibus insectorum, Surinamensium, t. 8 ; Plukenett, Amaltheum botanicum, p. 109 ; t. 207, f. 2. Native of Jamaica, Surinam and the main land of South America. It is grown in St. Vincent from seed. This and *P. alba* are also found in the island of Martinique, where they are particularly abundant in the commune of Sainte Lucie. It is also grown in Réunion. It is called by the French in the West Indies *Frangipanie Rouge* ; it is also called "Red Jasmine." It forms a tree of from 12 to 20

feet in height. The leaves are obovate-oblong, acute, with flat edges, glabrous, the peduncles are elongated, trifid, downy; the flowers crowded on fascicles. Corolla red, with a pilose throat and obliquely obovate-oblong segments which are rounded at the apex. In South America the women adorn themselves with these flowers and put them among linen to scent it, as we do Lavender.

P. alba, Jacquin, Stirpium Americanarum Historia, p. 36; t. 174, f. 12, coloured edition, t. 38; Lin., Sp. Pl., p. 307; Plumier, Icones plantarum Americanum, t. 231; Commelyn, Horti Medici, ii., p. 47, t. 24. Native of the West Indies, as of Jamaica and Martinique and of the main land of South America. It is called by the French in Martinique *Frangipanie blanc*. This tree is about 15 feet in height; the leaves are lanceolate-oblong with revolute edges, acuminated, about a foot in length; peduncles corymbose. Flowers white, with a yellow throat; spicate, ambrosiacal, exciting cephalagia. The corolla has a very long, thick incurved tube, and obovate-oblong oblique segments.

P. alba Var. β; *fragrantissima*, Humboldt, Bompland & Kunth, Nova plantarum genera, iii., p. 230; Syn. *P. bicolor* Ruiz et Pavon, Flora Peruviana et Chilensis, ii., p. 21, t. 141 (?). This is a native of New Granada and Peru and is found in the gardens of the Indians. It attains a height of 40 feet. The leaves are obovate-lanceolate, short-acuminated with flat edges, glabrous except the nerve and veins which are downy beneath; flowers paniculately spicate, very fragrant; corolla with a white limb and yellow throat. Tube of corolla green and ventricose at the base; segments of the limb obovate-oblong, obtuse, equal; throat hairy.

There is a scentless variety of *P. alba*, native of Carthagena, mentioned in Jacquin's work above quoted, p. 36. It is a tree of about 8 feet in height only.

P. pudica, Jacquin; as above, p. 37, t. 24 is a native of South America, and is highly esteemed in Curaçoa, where it is called *Donzelle*. The leaves are oblong, flat, veined. The limb of the corolla is closed. The corolla is yellowish and very sweet-scented. In height, this plant is only about 5 feet. The flowers succeed each other for two months together, and have an odour much more agreeable than that of any other species, and to some people, even more agreeable that that of any other flower.

P. purpurea, Ruiz et Pavon, Flora Peruviana et Chilensis, ii., p. 20, t. 137, is a native of Peru, and there found in gardens. It is a tree of 20 feet in height. The leaves are oblong-ovate, with revolute edges. The flowers are terminal and cymose; corollas reddish purple, with a yellow, hairy throat, smaller than that of the other species; they are very sweet-scented, and in Peru are used by the women to ornament their hair. It is considered that *P. incarnata* and *P. tricolor* (Ruiz et Pav., loc. cit., t. 138 and 139), both natives of Peru, are only varieties of *P. purpurea*, differing in the size and colour of the flowers. *P. bicolor*, Ruiz et Pav., loc. cit., t. 140, also a native of Peru, is a tree of about 25 feet in height, with oblong, acuminated leaves with flat edges; flowers corymbose: corollas cream coloured, with a curved tube, yellow throat and milk-white limb.

P. acuminata, Aiton, Hortus Kewensis, 2nd edn., ii., p. 70; Bot. Reg., 114. Syn. *P. acutifolia*, Poiret, Ency. methodique, supp., ii., p. 667. *P. obtusa*, Loureiro, Flora Cochin-Chinensis, p. 117. *Flos convolutus*, Rumph. Amb., vi., p. 35, t. 38. Native of Amboyna, China and Cochin-China. It is a tree of 20 feet in height. The leaves are scattered, lanceolate, acuminated, glabrous, flat, with many transverse veins. The flowers are terminal, in compound, spreading, upright racemes. The corolla is sweet-scented, white, mixed with red outside and yellow inside: tube curved: segments obovate. Follicles reflexed.

All the species of Plumieria are of easy culture. Large cuttings of them strike readily. The plants being of a rather succulent or fleshy nature, they require but little water when not in a free growing state.

Psidium.

This name is derived from ψιδιον, the Greek name of the Pomegranate. The Greek name is derived from ψιω, "to make small," in reference to the number of the seeds. (The seeds are really not small, but the fruit is small in comparison to the seed content).

Psidium is an extensive, but exclusively tropical genus of *Myrtaceæ*, consisting of trees or shrubs with opposite, entire, feather-veined leaves and large white flowers, growing either

singly, or a few together on axillary stalks, and producing fleshy berries crowned with the remains of the calyx-tubes, and containing numerous small, hard, kidney (or horse-shoe) shaped seeds nestling in pulp. The flowers have an egg-shaped calyx, with the lower part cohering with the ovary and the upper free part entire and closed in the bud, and at length coming off entire, or bursting into five, or rarely four lobes; four or five free petals; numerous stamens; and a two- or more-celled ovary, with many ovules in each cell. The flowers of nearly all the species are deliciously scented. The common name "Guava" is a corruption of the South American name *Guayaba*. About 45 species have been named, but they may not all truly belong to the genus. Some of the best known species may be briefly summarised as follows:—

P. Guyava, Linn.; Benth. Fl., Hongk., p. 120; Brandis For. Fl., p. 232; Grisebach, Flor. Brit. West Ind., p. 241; Journ. As. Soc. Beng., xlvi., pt. ii., p. 62. This species is indigenous to Mexico, and is now naturalised in most tropical countries and throughout India, where it is cultivated almost everywhere, except in the north-western corner of the Punjab. The species of *P. guyava* mostly grown in India are the *var. pyriferum* and *var. pomiferum*, Roxb., Fl. Ind., ii., p. 480. The former is 10 to 20 feet in height, a native of the Caribbee Islands and the continent of America, near Cumana. Bot. Reg., t. 1079; Ruiz et Pavon, Flora Peruviana, iv., t. 418; Rumph. Amb., i., t. 47; Trew, Plantæ selectæ ab ehret pictæ, t. 43. Syn. *Guayava pyriformis*, Gærtn. Fruct., i., t. 38. The second named variety, *V. pomiferum*, 6 to 15 feet in height, is a native of the West Indies, Mexico and South America, but is said by Loureiro to grow wild in Cochin-China; probably two species are confused. Rumph. Amb., i., t. 48; Merian, De metamorphosibus Swinamensium, t. 57. Jacquin (Plantarum rariorum horti Cæsarei Schœbrunnensis, iii., p. 62, t. 366) figures a variety of *P. pomiferum*, viz., *var. β, sapidissima* (native country unknown). Amongst other species may be cited the following:—

P. pumilum, Vahl. Symbolæ botanicæ, ii., p. 56; Blume, Bijdr. tot. de Flor. Ned. Ind., p. 1093: Rumph. Amb., 1, t. 49; Syn. *P. Angustifolium* Lam. Dic., iii., p. 16; Native of the Moluccas, Ceylon and Java. A variety, *β, Guadalupense*, of this (D.C., Prodr., iii., p. 233) is mentioned as being a native of Guadaloupe, but it is

possibly only a form of the Indian plant. Both are 2 to 3 feet in height.

P. aromaticum, Aublet, Hist. des plantes de la Guiane Française, i., p. 485, t. 191, is a native of the woods of Guiana and Cayenne; height 5 to 8 feet. The berry is yellow, hardly the size of a cherry. The bruised leaves have the smell of Balm. Native with this species is found a *var. β. grandiflorum* (Aublet, idem, t. 190); it is very like the first, but a smaller plant.

P. acutangulum, D.C., Prodr., iii., p. 233. A native of Brazil, near Ega. An acid variety of this is referred to by Martius as being found at Nogueira, in the province of Rio Negro, Brazil.

P. rivulare, Martius herbarium; a shrub of 6 to 10 feet; native of Brazil, between Coari and Ega by rivulet sides.

P. maribense, Martius herbarium, D.C., Prodr., iii., p. 233; a shrub of 6 to 10 feet; native of Brazil, at Maribi, near the river Tapura.

P. montanum, Swartz, Flora Indiæ occidentalis, p. 879. This species is a tree of 80 to 100 feet in height; native of Jamaica, on the mountains. The branches are tetragonal; leaves oval-oblong, acuminated, quite glabrous; peduncles many-flowered; fruit roundish, small, acid, smelling like the flowers of the bitter almond, hence it is called *Almandron.*

P. hians, Martius herbarium, D.C., Prodr., iii., p. 234; a shrub of 6 to 10 feet, native of Brazil, at Vaodo, Parama, in Tabuleira and Catingas.

P. turbiniflorum, D.C., Prodr., iii., p. 234; a shrub of 10 to 20 feet; native of Brazil.

P. striatellum, D.C., Prodr., iii., p. 233; a shrub of 10 to 12 feet; native of Brazil; is allied to *P. turbiniflorum*, but some observers consider it to belong to the genus *Myrtus*, an observation which also applies to *P. punctulatum*, a shrub of 4 to 6 feet, native of Brazil.

P. incanescens, D.C.; a shrub of 4 to 6 feet; native of Brazil, near Taubate, in the province of St. Paul. *P. cinerum*, D.C., may be a narrow-leaved variety of this.

P. grandiflorum, Martius; a shrub of 1 to 3 feet; native of

Brazil, found near Ypanema, in the province of St. Paul. It resembles *P. incanescens*, but the down on the leaves is more woolly. The leaves are 3 inches long.

P. rufum, Martius; a shrub of 4 to 6 feet. The tetragonal branchlets are densely clothed with rufous hairs. Native of Brazil, in mountain fields in the province of Minas Geraes. Leaves 4 inches long and 1½ or 2 inches broad.

P. pubescens, Martius; a shrub of 3 to 4 feet, native of Brazil, in the province of Pernambuco, near the river Termo.

All the above-named species have tetragonal branchlets. In all the following species the branchlets are terete:—

P. Guineense, Swartz, Flor. Ind. Occ., ii., p. 881. This species is cultivated in the West Indies, but is said to have been introduced from Guinea, and is called the "Guinea Guava." Its berry is of a dull yellow colour, rather pubescent, red inside, about the size of a nutmeg, and of exquisite taste. Height of the shrub 8 to 12 feet.

P. polycarpon, Trans. Lin. Soc., xi., p. 231, t. 17. Bot. Reg., 653. Native of the island of Trinidad. The middle flower on the peduncle is sessile, and the lateral ones pedicellate, as in the preceding and following species. Height of the shrub 3 to 6 feet. Fruit (which forms in abundance) about the size of a plum, of a delicate taste.

P. arica, Raddi, Mem. Flor. Brazil, 1821, p. 5, t. 1. Very nearly allied to *P. Guineense*, but the leaves are velvety above, not glabrous, and the nerves more elevated. Native of Brazil, near Rio Janeiro. Height of shrub 4 to 6 feet.

P. pluviatile or "River-side guava." Syn., *P. Guianense*, Persoon, Synopsis Plantarum, ii., p. 27. A shrub of 6 to 8 feet in height, native of Cayenne, and there found along the banks of rivers. The leaves are petiolate, oval, quite glabrous; the lower ones obtuse at both ends, but the upper ones are acuminated at both ends; pedicels opposite, 1-flowered, about 10 times the length of the petioles. The leaves are full of pellucid dots.

P. densicomum, Martius; native of Brazil, on the banks of the

Solunois and at Lake Ega. Height of the tree 20 feet, with a dense head.

P. littorale, Raddi., Mem. Flor. Brazil, 1831, p. 6, t. 1, f. 2. A shrub of 6 to 10 feet. Native of Brazil, on the sea-shore, where it is called by the inhabitants *Ariea de Praya.*

P. riparium, Martius. Native of Brazil, on the banks of rivers. Tree 20 or 30 feet in height, leaves 3 inches long and an inch broad.

P. guaviroba, D.C., Prodr., iii., p. 355. Native of Brazil, at Ypanema, in the province of St. Paul, where it is called by the inhabitants *Guaviroba de Canorro* or *Guaviroba de Campo.* The height of this shrub is from 6 to 10 feet. Fruit about the size of a large pea.

P. decussatum, D.C. Native of Brazil in the province of Minas Geraes. Height 2 to 3 feet.

P. desertorum, Martius; D.C., Prodr., iii., p. 236. Native of Brazil, in the desert of Bahia. Height 10 to 15 feet. Very nearly allied to this is *P. tenuifolium,* D.C.

P. oligospermum, Martius, D.C., is a shrub of 8 to 10 feet high, native of Brazil, in woods on the banks of rivers in the province of Bahia.

P. lanuginosum, Ruiz et Pavon, Syst. Veg. Flor. Peru., iv., t. 421, f. b. Native of Peru. Height 6 to 8 feet.

P. myrsinites, D.C., Prodr., iii., p. 236 ("Myrtle-like Psidium"). Native of Brazil, in deserts in the provinces of the mines: 12 feet in height.

P. Brownianum, Martius, D.C. A small, densely-branched tree, 10 to 12 feet in height; native of Brazil, in the desert of Bahia.

P. obovatum, Martius, D.C.; native of Brazil, in the province of St. Paul. Height 10 to 15 feet.

P. Cattleianum, Sabine, in Trans. Hort. Soc., London, iv., p. 315, t. 11; Lindley, Collectanea Botanica, t. 16; Bot. Reg., 622. A tree of 10 to 20 feet in height, a native of China, and distributed in Brazil.

P. cordatum, Bot. Mag., t. 1779. Native of Guadaloupe. Height 5 to 6 feet.

P. emarginatum, Ruiz et Pavon, Syst. Veg. Flor. Peru., iv., t. 418. Native of Peru. Height 8 to 10 feet.

P. macrostemon, Ruiz et Pavon, Ibid., iv., t. 420. Native of Peru.

P. rutidocarpon, Ruiz et Pavon, Ibid., iv., t. 420, f. b. Native of Peru.

Besides the above, there are about half-a-dozen doubtful species.

All species are of easy cultivation, either from seeds or cuttings.

Xylopia.

A genus of trees or shrubs belonging to the Natural Order *Anonaceæ,* indigenous to Brazil and other warm districts of South America, also in the West Indies. The genus is widely distributed throughout tropical regions, and although most abundant in South America and the West Indies, a number of species are known in West Africa, and one is a native of Mauritius. Species are also found in Ceylon and the Malayan Peninsula.

The name is derived from *ξυλον,* "wood," and *πικρος,* "bitter," in allusion to the bitterness of the wood of some of the species. Thirty or forty species are known; some are remarkable for the aromatic properties of their fruit and seeds. As general characters of the genus, the flowers have a 3- to 5-lobed calyx, with ovate leathery segments; 6 petals, the 3 outermost of which are largest; and numerous stamens on a globular receptacle, which also bears 2 to 15 carpels, each containing one or two seeds.

X. ferruginea, Hooker's Flora of Brit. Ind., i., p. 83. Syn. *Habzelia ferruginea,* Hooker and Thomson, Flor. Ind., i., p. 123. A flexuous, ramous shrub, native of Malacca. Its branchlets are rusty-pubescent. Leaves 5 to 7 inches by $1\frac{1}{2}$ to 2 inches, base oblique, rounded or subcordate, much reticulate, glabrous and shining above, glaucous beneath and rusty-pubescent on the veins, petiole $\frac{1}{4}$ to $\frac{1}{6}$ inch. Flowers pendulous, yellow, fragrant; peduncles $\frac{3}{4}$ to $1\frac{1}{4}$ inch, rusty pubescent; sepals ovate, acute; outer petals $\frac{1}{4}$ inch, taper, pointed, yellow, tomentose, the inner ones shorter, narrower, base contracted. Anthers with a long, narrow process; cells septate. Ovaries many. Seeds ovoid.

X. frutescens, Aublet, Hist. des plantes de la Guiane Française, i., p. 262, t. 292; Lam., Ill., t. 495; Dunal, Monographie de la famille des Anonaeées, p. 120. Syn. *X. setosa*, Poiret, Dietionnaire de Botanique, viii., p. 812. A shrub of 6 feet in height, native of Brazil and Guiana. The leaves are oblong-laneeolate aeuminated, their under surface silky. Peduncles 1 to 3, very short. Carpels smooth. The leaves and wood are very aromatie. The seeds are full of a very fragrant aerid oil and are used by the negroes in Guiana as a eondiment.

X. glabra, Lin. spee., 1367; Dunal, Mon. Anon., p. 121, t. 19. Plukenett, Almagestum botanieum, p. 395, t. 238, f. 4. A tree of 40 feet in height, native of Barbadoes and Jamaiea. Leaves oblong-ovate, smooth; peduneles 1-flowered, solitary or in pairs; earpels smooth. The wood, bark and berries of this tree have an agreeable bitter taste, not unlike that of an orange seed. The wild pigeons feed mueh upon these berries and owe their delicate bitter flavour so peeuliar to them, wholly to this part of their food. The bitter quality of this tree is eommunicated with great faeility. A handful of the shavings immersed in water and instantly taken out again, will render it of a very bitter taste. Sugar sent over in hogsheads made of this wood was so bitter, that no person would purehase it. Bedsteads and linen-presses made of it are proof against inseets. Carpenters who work the wood, perceive a bitter taste in their mouths and throats. A decoetion of the wood is said to aet as a tonie. It is ealled the "bitter wood" of Jamaiea. Perhaps, all the speeies of this genus partake, more or less, of this bitter quality. About 12 species are known. The plants of all the species ean be raised from seeds proeured from their native eountries, but should be sown immediately in a sandy loam and plaeed in a hot-bed, as they soon lose their vegetative property.

Ximenia.

A genus of trees or shrubs, named in honour of Ximenes, a Spanish monk, who published four books on the medieinal plants of New Spain (Plumier, Nova Plantorum Amerieanarum Genera, vi., t. 21, D.C., Prodr., i., p. 533). Plants of this genus of *Olacaceæ* are usually armed with spines, and the leaves are alternate, ovate or laneeolate, and exstipulate. The flowers are raeemose, usually

hermaphrodite; calyx cupular, 4- to 5-toothed, persistent; petals 4–5, oblong, revolute, hairy within; stamens twice the number of the petals, hypogynous; anthers innate, linear, 2-celled. Ovary sessile, superior, 4-celled; style columnar, stigma simple; ovules solitary in each cell, pendulous, anatropous. Drupe ovoid, 1-celled; stone solitary. There are only 4 or 5 species, one being Mexican, one South African, one Bornean, one Polynesian, and one widely dispersed through the tropics of both hemispheres.

X. Americana, Lin. Spec., 497. Willdenow, Species Plantarum, ii., p. 230. Roxb., Flor. Ind., ii., p. 252. Wight and Arnott, Prodr., i., p. 89. Miquel, Flor. Ind. Bot., i., pt. i., p. 787. Syn., *X. Russelliana*, Wall. Cat., 6784. Found both in the east and west of the Indian peninsula, Circar mountains, Andaman Isles, Malacca, Ceylon, Malayan Archipelago, tropical Africa and America. This shrub is about 15 feet in height; the branches are spreading, spinose, glabrous, covered with a red astringent bark, and often ending in a spine. Young shoots angular. Leaves 1¼ inch by 1 inch and upwards, coriaceous, glabrous, ovate-oblong or roundish, emarginate, base rounded, veination conduplicate. Petiole ½ inch. Flowers ⅓ inch, bisexual, sometimes polygamous, white, greenish-yellow inside, very fragrant, in short racemes, which are axillary or on the ends of thickened contracted shoots. Rachis terete, 4- to 6-flowered. Bractes minute. Buds oblong, acute. Calyx minute. Petals many times larger than the calyx, equal to the stamens in length. The fruit is yellow, about the size of a pigeon's egg, of a somewhat acid sweet taste, and is eaten by the natives. The wood also is odoriferous, and is used in Western India as a substitute for santal wood.

Var. a, ovata. D.C., Prodr., i., p. 533. Syn., *X. multiflora*, Jacquin, Stirpium Americanarum Historia, p. 106, t. 277, f. 31. Lam. Ill., t. 297, f. 1. Native of the West Indies and Brazil. Petals greenish; fruit yellow, drupaceous; leaves ovate.

Var. β, oblonga. D.C., Prodr., i., p. 533. Syn. *Heymassoli spinosa*, Aublet, Hist. des Plantes de la Guiane Française, i., p. 324, t. 125. Lam. Ill., t. 297, f. 2. Leaves oblong. Native of Guiana.

X. elliptica, Forster, Florulæ insularum australium prodromus, No. 162. Native of New Caledonia, the Fiji and other islands of

the Pacific. The leaves are elliptical-lanceolate; peduncles many-flowered. Branches unarmed. The round, orange-coloured fruits are eaten by the natives; in the unripe state they have a powerful odour of bitter almonds.

X. inermis, Lin. Spec., 497. Lunan, Hortus Jamaicensis, ii., p. 156; unarmed; pedicels 1-flowered; leaves ovate. Flowers small, greenish-yellow. Native of Jamaica.

X. Ægyptiaca, Lin. (Spec. 1194), is identical with *Balanites Ægyptiaca*, Delile Floræ Ægyptiacæ, t. 28, f. 1; and Prosper Alpinus De Plantis Ægypti, p. 20, t. 11; native of tropical Africa and cultivated in Egypt. An Indian variety of it is described by Roxburgh, Flor. Ind., ii., p. 253, and Wight, Icones, 274, as found in the plains of the Deccan, and having very fragrant flowers.

The tree has been previously referred to, p. 278, as probably furnishing an ingredient in the celebrated spikenard ointment.

As found in India the tree is described as being 20 feet in height; leaves alternate, bifoliate; spines axillary; calyx 5-parted: sepals villous; petals 5, lanceolate; pedicels 1-flowered; flowers aggregate, small, green; drupe ovoid, 1-celled, 1-seeded, with a woody, 5-angled nut. In India it is found at Goozerat, Hurripur, and in the Circars. It is one of the few trees which in Egypt flourish in a black soil.

Pergularia.

A genus of *Asclepiadaceæ* consisting of twining shrubs inhabiting India, China, the Moluccas and Madagascar, having broad ovate or cordate membranous leaves, and interpetiolar cymes bearing greenish or yellowish flowers, which are generally very highly scented. The greater number of the species are much valued for their fragrance, and on this account are cultivated in China and the East Indies. They are well adapted to training up rafters and trellis work; the name being derived from *pergula*, "an arbour." The calyx is 5-cleft, the corolla salver shaped, with an urceolate tube. The fruit is smooth and ventricose.

P. odoratissima, termed in Mauritius "Liane Tonquin," and in Java "Malatti Tunkat," is a native of China, Cochin-China, Sumatra and Java. The plant is said to be introduced into India

from Sumatra, where it is carefully cultivated in the English settlements on the west side of that island ; on that account it is generally called by the English in India, " the West Coast creeper."

The root is branched, widely - spreading. The stem is shrubby, round, branched, twining and climbing to a great extent, downy when young; the bark spongy and cracked when old. Leaves opposite, stalked, deflexed, heart-shaped, rather taper-pointed, entire, soft, opaque, veiny, downy at the veins and margin, paler beneath, 4 inches long and 3 inches broad. Panicles axillary, solitary, drooping, forked, many-flowered, downy. Flowers greenish yellow, size of a primrose. Calycine segments shorter than the tube of the corolla, which is woolly inside. Segments of corolla short, obtuse. Seeds surrounded by a membranous rind, and ending in long tuft of hairs. Bot. Rep., t. 185 ; Bot. Reg., t. 412. Syn., *P. minor*, in Bot. Mag., t. 755 ; *P. tomentosa*, Lin., Mantissa Plantarum, p. 53 ; *Asclepias odoratissima*, Roxb., Flor. Ind., ii., p. 46 ; *Cynanchum odoratissimum*, Loureiro Flora Cochin-Chinensis, p. 164 ; *Flos Siamicus*, Rumph. Amb., vi., p. 58, t. 26, f. 1 ; Smith, Icones Pictæ Plantarum rariorum, iii., p. 16.

P. accdens, Blume, Bijdr., p. 1056. Native of Java, Sumatra, Madura, &c., by the sea-side. Leaves ovate or oval-oblong, acuminated, rounded at the base, having the margins and veins downy ; cymes pedunculate, twin ; calycine segments obtuse, shorter than the tube of the corolla. It differs from P. odoratissima in the leaves never being cordate.

P. minor, Bot. Rep., t. 114 ; Tratt, observations botanicæ tabularum rei herbariæ illustrantes, 713. Bot. Mag., t. 755. This is probably only a small variety of *P. odoratissima* ; the leaves are rounder, with a more slender recurved acumen ; and the corollas orange-coloured or yellow, but also very fragrant; and the segments of the corolla are blunter and shorter. Leaves 1½ inches broad and the same in length. It is a native of the East Indies.

P. parviflora, Blume, Bijdr., p. 1056. Leaves sub-cordate-ovate, acute, downy on the margins and veins beneath ; umbellules pedunculate ; calycine segments obtuse, shorter than the tube of the corolla. Native of Java, about Kuripan, in calcareous soils.

P. villosa, Blume, Bijdr., p. 1057. Leaves sub-cordate-oval, acute,

very soft beneath; umbellules simple; segments of calyx acute, shorter than the tube of the corolla. Native of Java, on Mount Parang, in the province of Tjanjor.

P. sanguinolenta, Lindley, in Trans. Hort. Soc., vi., p. 72. Bot. Mag., 2532. Leaves ovate-lanceolate, quite glabrous; cymes many-flowered, shorter than the leaves; segments of corolla acuminated, obtuse. Native of Sierra Leone. This plant is of a trailing habit, and is full of a blood-coloured juice, which is used to adulterate the " Dragons' blood " of commerce.

Magnolia.

The name is given in honour of Pierre Magnol, who was a professor of medicine, and died in 1715. The genus gives its name to the Order *Magnoliaceæ*, and consists for the most part of large trees with fine foliage and handsome, fragrant flowers.

The species of this Order are chiefly natives of mountainous countries. They are probably more abundant in Western China, in eastern continental India and in the Indian Archipelago, than in any other part of the world. Many species occur in the more humid parts of the temperate Himalaya, but one only extends as far west as Kumaon. The western provinces of India produce only two species, and Ceylon not more than one. From China several extend to Japan. North America, excluding Mexico, which seems to contain several species of this family, produces eight species. A few are natives of the West Indies and the mountainous parts of tropical South America. In Africa they appear to be entirely wanting.

The plants of this family are all more or less aromatic, and their flowers have often an extremely powerful perfume. The Himalayan species are large trees, and yield valuable timber. The bark of many of the American species possesses bitter and tonic qualities, but none of those of India are known to do so. The leaves of the various species of the *Magnoliastrum*, or True Magnolia (D.C., Syst., i., p. 450; Prod., i., p. 80), are alternate, entire, deciduous or evergreen, rolled round in the bud, in which state they are protected by the stipules, which originally adhere to the sides of the leaf-stalks, but ultimately fall off. The flowers are large, terminal, protected in the young state by scales that seem to

be of a stipulary nature. The calyx consists of three deciduous sepals; the corolla of six to twelve petals like the sepals; stamens and ovaries numerous, on a prolonged receptacle. The fruit consists of a number of follicles, in a compact spike, and opening along their outer edge to allow of the escape of the scarlet or brown seeds, which are suspended from the carpels by long slender threads. The species number about 70.

M. grandiflora, Lin. Spec., 755. This very stately, elegant, evergreen tree, the noblest of all the species, attains in its native country a height of 70 to 100 feet, dividing into many branches, which form a large pyramidal head. It is a native of North America, and extends through the forests, in marshy places, from North Carolina to Louisiana. The leaves are oval oblong, 9 or 10 inches long, much resembling those of the common laurel, coriaceous, the upper surface shining, of a rather light green above, but the under surface rusty-brown. The flowers are large, erect, cup-shaped, expanded, white or pale lemon-coloured, 9- to 12-petalled, and have an exquisite fragrance.

In America it flowers the greater part of the summer, beginning in May, and produces its rich brown spikes of fruit in the autumn; but in England it does not begin to flower before July, and then its flowers are inferior in size and in perfume to those produced in its native habitat. Being more tender than the other American species, it is generally grown against a south wall in England. Lam. Ill., p. 490; A. F. Michaux fils, Histoire des arbres forestiers de l'Amerique septentrionale, iii., p. 71, t. 1.; Duhamel de Monceau, Traité des Arbres (Ed. nov., 1801-1816), ii., p. 219, t. 65.

Var. α rotundifolia. Sweet, Hortus Britannicus, p. 11. Leaves roundish.

Var. β obovata. Leaves obovate-oblong; flowers expanded. In Carolina this variety is known by the name of "Big Laurel." Aiton, Hortus Kewensis, Ed. 2, iii., p. 329.

Var. γ elliptica. Leaves oblong-elliptical; flowers somewhat contracted, Aiton Hort. Kewensis, Ed. 2, iii., p. 329; Bot. Cab., t. 814; Miller, figures of plants described in the Gardeners' Dictionary, ii., t. 172. This variety is called the Exmouth variety. It is hardier than the other varieties, and flowers earlier.

Var. δ *ferruginea.* Leaves oblong-lanceolate, under surface rusty: flowers somewhat contracted. Bot. Mag., t. 1952. This variety flowers at a smaller size than the other varieties.

Var. ε *lanceolata.* Leaves oblong-lanceolate; flowers sometimes contracted. Aiton, Hortus Kewensis, Ed. 2, iii., p. 329. Figured in Bot. Rep., t. 518 as *M. grandiflora.*

M. glauca, Lin. Spec., ed. 2, p. 755. Schkuhr, Botaniches handbüch, No. 1441, t. 148. Loddiges, Bot. Cab., t. 215; Bot. Mag., t. 2164. Michaux fils, Hist. des arbres forestiers de l'Amérique septentrionale, iii., p. 77, t. 2. Duhamel, traité des arbres, 2 ed., ii., p. 223, t. 66. Bonpland, Descriptions des plantes rares, p. 103, t. 42. Bigelow, American Medical Botany, t. 27.

The leaves of this species are almost deciduous; they are elliptical, obtuse, and glaucous on the under surface. Flowers 9- to 12-petalled, contracted, petals ovate, concave, white or cream-coloured, strongly scented. The height of the tree is usually from 15 to 20 feet. It is a native of North America, in low, moist swampy ground at a little distance from the sea, from Massachusetts to Florida and Louisiana, especially in New Jersey and Carolina. In America this tree is known by the names of White Laurel, Swamp Laurel, Swamp Sassafras, Sweet Bay and Beaver tree. The last name is due to the fact of the root being eaten as a great dainty by beavers, and these animals are trapped by means of it. Kalm says these trees may be discovered at a distance of 3 miles by the scent of their blossoms, if the wind be favourable. It is beyond description pleasant to travel in the woods at the flowering season, especially in the evening. The trees retain their flowers for three weeks and even longer. The berries are of a rich red colour, and hang in bunches on slender threads. It has been remarked that the flower never opens in the morning; that the calyx falls off at the second opening of the flower, but that the petals dry on. The scent somewhat resembles that of the lily of the valley, but more aromatic.

M. longifolia, Sweet, Hortus Britannicus, p. 11 (*M. glauca, var. longifolia*, Aiton, Hortus Kewensis, ed. i., ii., p. 251. Pursh, Flora Amer. Septentrionalis, ii., p. 381. The "Evergreen Swamp Magnolia," a very handsome tree, about 30 feet in height; native of Florida and Georgia. Leaves evergreen, elliptical, acute at both

ends, under surface glaucous: flowers 9- to 12-petalled, contracted; petals ovate, concave, white, very sweet-scented.

M. umbrella. Lam., Dict., iii., p. 673. *M. tripetala,* Lin. spec., ed. 2, p. 756. Michaux fils, Hist. des arbres forestiers de l'Amér. sept., iii., p. 90, t. 5. Pursh, Flor. Amer. Sept., ii., p. 381. *M. frondosa,* Salisbury Prodromus, p. 379. Leaves deciduous, lanceolate, spreading, from 1 to 2 feet long, placed at the ends of the branches in a circular manner, somewhat like an umbrella, whence its name. The adult leaves are smooth, the younger ones pubescent underneath. The flowers are 2 or 3 inches in diameter, white and sweet-scented. This perfume is by some considered heavy and oppressive. Petals 9 to 12, exterior ones pendant. This species is a native of North America, on wooded mountains from New York to Carolina and Georgia, as well as Virginia. The wood is soft and spongy; in the mountains of Virginia it is called "Elk-wood."

M. auriculata. Lam., Dict., iii., p. 673. *M. auricularis,* Salisbury, Paradisus Londinensis, t. 43: Bot. Mag., t. 1206. Michaux fils, Hist. des arbres forestiers de l'Amér. Sept., iii., p. 94, t. 7: Bot. Rep., t. 573. Pursh, Flor. Amér. sept., ii., p. 382. *M. Fraseri,* Walter, Flora Caroliniana, icon. 159. A tree of 40 to 50 feet high. Leaves deciduous, smooth, under surface somewhat glaucous, spatulately-obovate, cordate at the base, with blunt, approximate auricles. Flowers erect, of a yellowish-white colour and remarkably sweet-scented; 3 or 4 inches in diameter; sepals 3, spreading; petals 9, oblong. The fruit is rose-coloured. This species is native of North America in the Alleghany mountains from the upper waters of the Sesquehanna to Carolina. The tree will blossom when very young.

M. pyramidata, Bot. Reg., t. 407. Deciduous. Leaves smooth; the same colour on both surfaces, spatulate-obovate, cordate at the base; auricles spreading; sepals 3, spreading; petals 9, lanceolate, pointed. Native of the western parts of Carolina and Georgia. Very like *M. auriculata,* but it grows in a more pyramidal form, and besides the above-described differences, the leaves are not above half the size.

M. macrophylla, Michaux, Flora boreali Americana, i., p. 327. Michaux fils, Hist. des arbres forestiers, iii., p. 79, t. 7. Bot. Mag., t. 2189. Bonpland, Descrip. des plantes rares, t. 33. A beautiful

tree, about 35 feet in height, with a white, smooth bark. The leaves are from 1 to 3 feet long and from 8 to 10 inches broad, deciduous, oblong-obovate, somewhat panduriform, cordate at the base, under surface white, glaucous. Flowers white, and purple at the base, sweet-scented, 8 to 10 inches in diameter; petals 6 to 9, ovate. Native of North America, in moist, swampy, shady places, about Lincolton in Upper Carolina and in the deep forests of Tennessee.

M. Campbelli, Hooker and Thomson, Flora Indica, i., p. 77. Hooker fil, Ill. Him. Plant., t. 4 and 5. Griffith, Icones, iv., t. 656. A very lofty tree, inhabiting the dense forests of Sikkim and Bhotan and at altitudes of 8,000 to 10,000 feet in the Eastern Himalaya. The leaves are deciduous, elliptic-ovate or oblong-ovate, or acuminate, membranous, 4 to 12 inches long by 2 to 4 inches wide, glabrous above, glaucous, pubescent or silky beneath, base cordate, rounded or oblique, petiole 1 inch. Flowers 6 to 10 inches in diameter, very fragrant, pink, occasionally white. Hooker and Thomson remark that this superb species, which is so conspicuous a feature in the scenery of Sikkim (the trees attaining a height of about 150 feet) will aptly record the services of Dr. Campbell, resident at Darjiling, in connection with the rise and progress of that important place and also his many contributions to our knowledge of the geography and productions of the Himalaya. It flowers in the month of April, when quite leafless. The shape and clothing of the leaves varies more than is usual in the genus; on very young trees the leaves are quite glabrous, and much more membranous than on the adult plant.

M. globosa, Hooker and Thomson, Flora Indica, i., p. 77. A tree of about 40 feet in height, native of the interior, temperate ranges of the Sikkim Himalaya at altitudes of 9,000 to 10,000 feet. The branches are brown; when young, tomentose; when old, glabrous. Leaves 5 to 9 inches long by 3 to 6 inches wide; the nerves of the under surface are tomentose. Flowers 4 to 5 inches in diameter, globose, white, fragrant. Peduncles terminal, single, densely tomentose. This is the species which attains the greatest elevation and penetrates furthest into the interior of the Himalaya.

M. sphenocarpa, Hooker and Thomson, Flor. Ind., i., p. 78. Roxb., Cor., iii., t. 266. Wall. Cat., 975. Syn., *Liriodendron grandiflorum* Roxb., Flor. Ind., ii., p. 65. *Michelia macrophylla*, Don. Prod. Nep.,

p. 266. *Talauma Roxburghii*, G. Don, Gen. Syst., i., p. 85. A native of tropical Himalayan forests from Nepal to Assam, Khasia Hills and Chittagong, at an altitude of 3,000 feet. Leaves evergreen, oblong, obtuse or subacute, glabrous on both sides, or puberulous beneath, 8 to 16 inches in length by 3 to 6 inches in width, tapering at the base; thick, coriaceous. The young parts of the plant are hoary, at length glabrate. The buds are globose, appearing with the leaves, 2 inches in diameter. Flowers white, fragrant. Petals 6, oval, fleshy. Fruit 8 to 16 inches. Carpels very long beaked, beak compressed.

M. excelsa, Wallich, Tentarum floræ Nepalensis illustrata, t. 2. Native of Nepal. A magnificent tree of 50 to 80 feet in height. Leaves oblong-elliptical, acuminated, glaucous and netted with veins beneath; buds bearded with rusty hairs. Flowers axillary, solitary, 12-petalled, large, white, sweet-scented. Carpels globose, remote, 1-seeded. The wood of this tree is greatly prized by the inhabitants of Nepal at Patma, where it is employed in joinery, and is commonly sold under the name of "Champ."

M. yulan, Desfontaines, Hist. des arbres, ii., p. 6. Bonpland, Descrip. des plantes rares, p. 53, t. 20. Syn. *M. precia* Correa, in Ventenat, Jardin de la Malmaison, No. 24. *M. conspicua*, Salisbury, Paradisus Londinensis, 38, t. 38. Bot. Mag., 1621. Native of China, where it attains a height of 30 or 40 feet, and is called Yu-lan. It has been cultivated in China since the year 627. Leaves deciduous, obovate, abruptly acuminated, younger ones pubescent, expanding after the flowers. Flowers erect, 6- to 9-petalled; styles erect. This species is hardy in England and is at an early age covered, from February to April, with innumerable sweet-scented flowers, which are white and sometimes suffused with purple and are expanded throughout the day-time, but the severe east winds injure its beauty unless it be protected or planted in a conservatory; also the climate of Northern Europe stunts it to such a degree, that it only attains a height of 8 or 10 feet, or about a fourth of its natural size.

M. Kobus, D.C. Syst., i., p. 456. Syn. *M. gracilis*, Salisbury Paradisus Londinensis, t. 87. *Kobus*, Banks, Icones selectæ plantarum Japonica, t. 42. *M. glauca var a*, Thunberg, Flora Japonica, p. 236. *M. tomentosa*, Thunberg in Trans. Lin. Soc., ii., p. 336. In Japan this tree attains a height of 10 feet and is called

"Kobus" or "Side Kobusi." It has a rough bark which smells like camphor. Leaves obovate, acuminated at both ends, deciduous, produced after the flowers, the younger ones pubescent underneath, adult ones smooth. Flowers erect and solitary with the outside segments purple and the inside white; 3 sepals and 6 petals; styles reflexed. Ovaries purple. Very fragrant.

M. obovata, Thunberg in Trans., Lin. Soc., ii., p. 336. Native of Japan and cultivated both in Japan and China. Deciduous; leaves obovate, acute, reticulately veined, almost smooth. Flowers erect, of 3 sepals and 6 obovate petals; styles very short.

Var. a, denudata, Lam. Dic., iii., p. 675; Banks, Icones selectæ plantarum Japonica, t. 43; Syn. *M. glauca, var. β*, Thunberg, Flora Japonica, p. 236. Native of the island of Nipon, in Japan. Flowering branches without leaves; Flowers red; petals obovate.

Var β, discolor, Ventenat, Jardin de la Malmaison, No. 24, t. 24. Syn. *M. purpurea*, Bot. Mag., t. 390. Bot. Rep., t. 324. Flowering branches leafy. Flowers purple outside but whitish inside. Petals obovate, of two colours: fragrant.

Var γ, latifolia, Lam. Dic., iii., p. 657: Banks, Icones selectæ plantarum, t. 44. Native of China. Flowering branches leafy. Flowers white, fragrant: petals oblong, white on both sides. Height 5 feet.

M. Soulangeana, Sweet, British Flower Garden, t. 260; Bot. Reg., t. 1164. This is a hybrid raised from the seed of *M. Yulan* by Soulange Bodin; the other parent is supposed to be *M. obovata var. β discolor*. It is a deciduous shrub of 5 or 6 feet in height. Leaves obovate, abruptly acuminated, veiny, pubescent on both surfaces. The flowers are of 6 obovate, expanded, whitish petals tinged with purple. Sepals 3.

M. fuscata. A very ramous shrub of only 3 or 4 feet in height; native of China, where it is cultivated on account of the exquisite and powerful fragrance of its flowers, noticeable even at a distance. Leaves elliptical-oblong, obtuse, the adult ones smooth. Branches and petioles covered with brown tomentum. The flowers are axillary, solitary, rather small for a Magnolia, very pale yellow, or cream coloured. It is noticed that varieties of it are of a dull

purple colour. The calyx is spathaceous: petals 6, lanceolar. Roxb., Fl. Ind., ii., p. 655; Bot. Rep., t. 229; Bot. Mag., t. 1008. Syn. *M. fasciata* Ventenat, Jardin de la Malmaison, No. 24, adn. 2.

> *Var.* β, *annonæfolia*, Salisbury, Paradisus Londinensis, No. 5, t. 5. Native of China; leaves broader; pedicels a little shorter; flowers more red; anthers more numerous.

> *Var.* γ, *hebeclada*, D.C., Syst., i., p. 458. Native of India. Flowers on shorter peduncles; branches more velvety-tomentose: leaves shorter.

M. pterocarpa, Roxb., Cor., iii., p. 62, t. 266 Native of Silhet and Chittagong. In Silhet it is called "*Doolee champa*." Height 40 feet: leaves oblong, with tapering base, entire. Flowers terminal, solitary, white, sweet-scented, as large as those of *M. grandiflora*. Sepals 3, green on the under side. Petals 6. Seeds red. Strobile winged. Anthers red and yellowish.

M. coco, D.C., Syst., i., p. 459. Syn. *Liriodendron coco*, Loureiro, Flora Cochin-Chinensis, Ed. Willdenow, i., p. 424. A shrub of 5 feet in height. Native of Cochin-China, Macao and Canton, where it is cultivated for the beauty and scent of the flowers. Leaves ovate, quite entire, shining. Flowers solitary, very large, pure white, with an exquisite scent; sepals 3, oblong—these as well as the petals are incurved; petals 6, fleshy; ovaries 8. The flower-bud before opening is roundish, and is likened to the coco-nut;* whence the name at Macao, "Fula-coco."

M. Figo, D.C., Syst., i., p. 460. Syn. *Liriodendron Figo*, Loureiro, Flora Cochin-Chinensis, Ed. Willdenow, i., p. 424; *Michelia Figo*, Sprengel, Systema vegetabilium, ii., p. 643. Native of China, where it is also cultivated, especially about Macao and Canton. By the inhabitants of Macao this shrub, which is about 4 feet in height, is called "Fula-Figo." Leaves lanceolate, quite entire, shining, reflexed-incurved. Flowers solitary, pale, spotted with red on the inside, fragrant; petals 6, ovate-oblong, erect; ovaries 40 or 50. There is only one bract† enclosing the flower-bud, therefore this plant may be a species of Michelia.

* As regards the fashion of spelling "coco-nut," see Table of Corrigenda at end of this volume.

† See also table at end.

Under cultivation the species of Magnolia are generally propagated by layers put down in spring or autumn. When the layers are first taken off, they should be potted in a mixture of loam and peat in a close frame till they have taken fresh root. None of the leaves should be taken off or their tops shortened; the more branches and leaves are on them the sooner they will strike fresh root. The Chinese kinds are often inarched or budded on *M. obovata*, which takes readily. *M. pumila*, *M. fuscata*, *M. annonæfolia*, and any of the weak-growing kinds, strike readily from cuttings taken off as soon as ripe, and planted in a pot of sand and placed under a hand-glass.

M. glabra and *M. longifolia* like a peat soil and a moist situation. When plants are raised from seeds, these should be sown as soon after their arrival from their place of production as possible, in pots or boxes of light rich earth, covering them half an inch deep; these may be placed either in a hot-bed, or in a warm, sheltered situation, or in a warm climate they may be sown in the open ground, and when the plants are of sufficient size they can be planted out singly, and should then be shaded until they take fresh root. In transplanting, none of the roots or leaves should be shortened.

Talauma.

One of the genera of Magnoliaceæ, so called from the native name applied to some of the South American species. The genus consists of magnificent trees and shrubs, resembling magnolias, and belonging to tropical and sub-tropical regions of the Old and New World. They are remarkable for their fine fragrant flowers.

T. Plumiera, Swartz, Flora Indica occidentalis, ii., p. 297; Syn. *Magnolia Plumiera*, Swartz, Prodromus descriptionum vegetabilium Indiæ occidentalis, p. 87; *Anona dodecapetala*, Lam. Dic., ii., p. 127. *T. cærulea*, Jaume St. Hilaire, exposition des familles naturelles, ii., p. 76. A tree of 50 to 80 feet in height; native of Martinique, Guadaloupe and Ste. Lucie. Leaves ovate-roundish, somewhat cuneated at the base, coriaceous, smooth, reticulately veined. Flowers large, white, sweet-scented, solitary on the tops of the branches; petals 12, thick, oblong, obtuse. The flowers are used by the distillers in Martinique to flavour liqueurs.

Var. β, D.C., Prodr., i., p. 82. Leaves obovate oblong. Native of Dominica. Height 50 to 80 feet.

T. ovata, Saint Hilaire, Floræ Brasiliæ meridionalis, i., p. 26. t. 4, f. A. Syn. *Magnolia ovata* Sprengel. Native of Brazil, in the western part of the province of Minas Geraes, in marshes. Leaves 5 to 7 inches long and 3 to 4 broad, ovate. Flowers of 6 petals, white. Height 20 feet.

T. Candollii, Blume, Bijdr. Fl. Ned. Ind., i., p. 9; Flor. Jav. fasc., 19, p. 32, t. 9. Syn. *Magnolia odoratissima* Reinwerdt, *Magnolia pumila* Sprengel. Native of Java. Height about 6 feet. Leaves oblong, acuminated at both ends. Flowers large, cream-coloured, 9- to 12-petalled, outer ones short; peduncles 1-flowered, rather drooping, and are, as well as the petioles of the younger leaves, clothed with rufous villi. Stem shrubby.

Var. β, latifolia, Blume, loc. cit., Leaves broader, and less attenuated at the base.

T. Rumphii, Blume, Bijd., Flor. Ned., i., p. 10, and Flor. Jav. fasc., 19, p. 39. Syn. *Magnolia Rumphii*, Sprengel. *Sampaca montana*, Rumph. Amb., ii., t. 69. Native of Java and the Moluccas. Leaves oblong-lanceolate, very much acuminated. Peduncles 1-flowered, erect. Flowers pale yellow or cream-coloured, terminal; sweet-scented; petals 6. This is a tree of 30 feet in height.

T. pumila, Blume, Flor. Jav., fac. 19, p. 38, t. 12; Syn. *Liriodendrum lilifera*, Lin. Spec., 755; *Magnolia pumila*, Bot. Rep., t. 226; Ventenat, Jardin de la Malmaison, t. 37; Bot. Mag., t. 977. Native of Amboyna and Java, on high mountains. Leaves elliptical, acuminated at both ends, reticulately veined. Flowers drooping, 6- to 9- petalled, cream-coloured. Very fragrant at night.

T. Mexicana. Syn. *Yeloxochitl Aristochyca*; *Magnolia grandiflora*, Mocino and Sessé, Flora Mexicana. *Magnolia Mexicana*, D.C., Syst. i., p. 451. Native of Mexico. 50 feet in height. Leaves oval, tapering a little at the base, blunt. Flowers long, white, purplish inside, sweet-scented; 9-petalled, expanded; petals ovate, flat.

T. Hodsoni, Hooker and Thomson, Flor. Ind., p. 74. Hooker fil, Ill. Him. Pl., t. 6. A lofty evergreen tree, occurring in dense

forests of the Sikkim Himalaya and on the Khasia Hills at altitudes of 4,000 to 5,000 feet. Leaves ovate-oblong, acute or obtuse, glabrous; 8 to 20 inches long, 4 to 9 inches wide, petiole 1 to 2 inches. Flowers white, fragrant; peduncle short, thick; buds subglobose, 2 to 3 inches in diameter. Fruit ovoid, 4 to 6 inches; carpels sharply beaked.

T. lanigera. A tree inhabiting the Eastern part of the peninsula of India. Leaves lanceolate, acute at both ends, glabrous, 12 inches long by five inches wide, petiole 1 inch. Flowers large, odorous; peduncle densely tomentose. Sepals 3, tomentose, at length glabrate, petals about 8, oblong, fleshy, exceeding the sepals.

Aromadendron elegans, Blume, Bijdr. Flor. Ind. Ned., i., p. 10; also Flor. Jav. fasc., 19, p. 25, t. 7 and 8. A large elegant tree of the Order Magnoliaceæ, 80 to 140 feet in height; native of Java, on the mountains. It has oblong-lanceolate leaves, and terminal, solitary, large, white, very fragrant flowers, at length changing to a straw colour. The calyx consists of 1 spathaceous leaf. Petals very narrow and very numerous, about 28, disposed in a quarternary order. Stamens numerous, awl-shaped, anthers bursting outwardly. The flowers diffuse their fragrance to a considerable distance. Carpels 2-seeded, joined together into egg-shaped ligneous fruit. The genus is easily distinguished from *Talauma* by the number of the petals. The bark is a grateful aromatic bitter.

Gardenia.

A genus of *Cinchonaceæ,* consisting of trees or shrubs, frequently spiny, indigenous in tropical Asia and Africa, also at the Cape of Good Hope. This genus is valued for the beauty and fragrance of its flowers, which are axillary or terminal, usually solitary, and white.

G. Florida, Lin. spec., p. 305. Bot. Reg., t. 449. Syn. *G. jasminoides,* Soland, Phil. Trans., lii., t. 20. Plukenett, Amaltheum botanicum, t. 448, f. 4. *Jasminum Capense,* Mill. Dict., No. 7; figures of plants, t. 180. Ehret., Plantæ rariores, t. 15. Native of

Japan and China, and cultivated in India. (Hooker and Thomson, Flor. Ind., iii., p. 115; Roxb., Flor. Ind., i., p. 703; Wall., Cat. 8268; Willd., Spec., i., 1225). Its Sanskrit and Bengalee name is "Gundhuraja." It is the "Catsjopiri of Rumphius (Amb., vii., p. 26, t. 14, f. 2). In China, where its flowers are used for scenting tea, it is called "Pak-sema-hwa." An erect shrub of 2 feet to 6 feet in height, much branched, unarmed. Leaves elliptic, acute at both ends. Flowers solitary, almost terminal, sessile, salver-shaped, white, sweet-scented, 5- to 9-parted; calycine segments vertical, lanceolate-subulate, equalling the tube of the corolla in length. Berry elongated, turbinate, ribbed, 5- to 6-celled at the base, 1-celled at the apex, orange-coloured, size of a pigeon's egg; the pulp is used for dyeing yellow in China and Japan.

Var. β, flor pleno; Syn. *G. jasminoides*, Ellis, in *Phil. Trans.*, li., t. 23. *Jasminum Capense*, Miller, figures of plants described in the Gardeners' Dictionary, t. 180; Rumph., Amb., vii., t. 14, f. 2. Flowers sometimes four inches in diameter, double, white. It is one of the finest shrubs in cultivation.

G. Radicans. Thunberg, Dissertatio de Gardenia, No. i., t. i., f. i. Thunberg, Flora Japonica, t. 20; Bot. Reg., t. 73; Bot. Rep., t. 491. A shrubby, unarmed plant, 1 to 2 feet in height; stems radicant, leaves lanceolate; flowers solitary, almost terminal and nearly sessile, salver-shaped; white, very fragrant; segments of the calyx vertical, linear-subulate, equal in length to the tube of the corolla. Native of Japan and cultivated in the East Indies and at the Cape of Good Hope.

G. calyculata. Roxb., Flor. Ind., ii., p. 550. A native of the mountainous parts of India, arboreous, unarmed. Leaves ovate, petiolate, acuminated, smooth. Flowers terminal, solitary, sessile, involucrated; calycine segments ensiform. Anthers enclosed within the swelling tube of the 5-cleft corolla. Flowers large, white, and, like most of the genus, fragrant.

G. Costata. Roxb., Flor. Ind., ii., p. 550. Syn. *G. coronaria* in Symes' Account of an Embassy to the Kingdom of Ava, p. 474, with a figure. A tree of 20 feet in height, unarmed, leaves cuneiform-oblong, smooth, ribbed; length 6 to 12 inches, and breadth from 3 to 5 inches; flowers terminal, or nearly so, very

large, the tube being above 3 inches long and the border above 4 inches diameter, salver-shaped, 5-parted; calycine segments resiniferous, caducous, white, sweet-scented. Anthers 5, sessile, completely within the mouth of the tube. Native of the mountainous parts of India; from those of Chittagong it was introduced to the Botanic Garden of Calcutta. The berry of this species is yellow and contains a soft and rather fetid pulp.

G. angustifolia, Loddiges Bot. Cab., t. 512. A shrub of 3 feet in height; very like *G. Florida*, from which it chiefly differs in being smaller and having narrower leaves. Flowers white, sweet-scented.

G. tomentosa, D.C., Prodr., iv., p. 379. An unarmed shrub, native of Java. Branchlets, leaves and calyces clothed with velvety tomentum; leaves obovate-cuniated. Flowers terminal, sessile, solitary; tube of calyx angularly ribbed; calycine teeth 10. Lobes of corolla 10, obovate-oblong; tube hardly longer than the calyx. Flowers white, sweet scented.

G. carinata, Wallich, in Roxb., Fl. Ind., ii., p. 560. Griffith, Notul., iv., p. 261; Icones, Pl. Asiat., t. 474, f. 3. Arborescent, unarmed, resinous in the younger parts; leaves, elliptic-obovate, ribbed, villous beneath. Flowers terminal, solitary, smaller than those of *G. costata*, at first snow-white, but afterwards yellow, becoming when dry of a beautiful orange colour. Limb of calyx truncate, broad, obscurely 5-lobed and 2-keeled; tube of corolla very long; limb 6- to 8-lobed. Fruit precisely as in *G. costata*. Native of Penang, where it grows on the Hills.

G. coronaria, Symes' Embassy in Ava, iii., p. 307, t. 22. Kurz., For. Fl., ii., p. 43. A deciduous tree 25 to 30 feet; branches stout, youngest hairy. Buds resinous. Leaves 6 inches to 12 inches in length by 3 inches to 5 inches in width, sub-sessile, obovate, shortly acuminate, shining above, glabrous or pubescent beneath, nerves about 20 pairs, stipules ½ inch. Flowers, sub-sessile, terminal, white changing to yellow, fragrant. Corolla 5-lobed, tube 2 to 4 inches.

G. grandiflora, Loureiro, Flora Cochin-Chinensis. Blume, Bijdr., p. 1013. A medium sized, unarmed tree. Leaves lanceolate, shining; flowers solitary, lateral and terminal, large, white, fragrant; segments of calyx reflexedly-falcate; corolla salver-shaped, 6-parted. Native of Cochin-China, on the banks of rivers.

G. latifolia, Aiton, Hort. Kew., i., p. 294. Roxb., Cor., ii., p. 18, t. 134; Flor. Ind., ii., p. 552. Wight, Ic., t. 759 (*G. latifolia*, Gærtn., Fruct., iii., p. 78, t. 193, is a distinct species). A tree of 10 feet in height, unarmed. Leaves almost sessile, ovate or obovate, opposite or 3 in a whorl; in the axils of the veins beneath are hollow glands with hairy margins. Flower terminal, 1-4 together, almost sessile, salver-shaped, 7- to 11-parted; limb of calyx short, subdentate; these flowers are very large and very fragrant; when they first open in the morning they are white, gradually growing yellow before night. Berry drupaceous, round, size of a pullet's egg, 1-celled, 5-valved, crowned with a small part only of the tube of the calyx. Native of the East Indies, on barren, rocky hills, in the Circars and Carnatic.

G. lucida, Roxb., Fl. Ind., ii., p. 553; Hort. Beng., p. 15. D.C., Prod., iv., p., 381. Wight, Ic., t. 575. Syn., *G. resinifera*, Roth., Nov. Sp., p. 150; Kurz., For. Fl., ii., p. 42. A small deciduous tree, unarmed, having resinous buds. Leaves oblong, smooth, shining, about 3 to 10 inches long by 2 to 5 inches broad; stipules large, broadly ovate. Flowers almost terminal, solitary, on short pedicels, large, pure white at first, turning yellow, fragrant; lobes of calyx 5, subulate, three times shorter than the mouth of the corolla. Berry drupaceous, containing a 2-valved shell. Native of Chittagong, and common in many parts of the western peninsula. It also occurs on the island of Luzon.

G. arborea, Roxb., Fl. Ind.. ii., p. 554. An arboreous, unarmed species. Leaves ovate-oblong. Flowers terminal, almost sessile, usually by threes; corolla with a filiform tube and a 5-parted limb; berry drupaceous, smooth, containing a 4- or 5-valved shell. Native of the East Indies, among the Circars. The leaves are deciduous during the cold season, and the shrub continues naked till the hot season is pretty far advanced. From the buds and wounds made in the bark, there exudes a beautiful yellow gum-resin, somewhat resembling Elemi. This exudation has also been noticed in *G. lucida* and *G. gummifera*. The size, number, fragrance and beauty of the flowers of this species render it very deserving of cultivation. The natives eat the fruit when ripe.

G. gummifera, Lin. fil. suppl., i., p. 164. Thunberg, Dissertatio ad Gardenia, No. 4, t. 2, f. 3. A shrub of 3 or 4 feet in height;

native of Ceylon and Coromandel: unarmed, buds resinous. Leaves oblong, bluntly acuminated. Flowers axillary, solitary, short-peduncled, white, fragrant.

G. clusiafolia, Jacquin, Collectanea ad botanicum, p. 37, t. 4, f. 3. Catesby, Nat. Hist. of Carolina, i., p. 59, t. 59. An unarmed shrub of 5 feet in height: leaves obovate, retuse and somewhat emarginate, coriaceous, on short petioles; peduncles almost terminal, racemose. Flowers on long pedicels, white, with a greenish tube, fragrant: limb of calyx short, 5-toothed; corolla salver-shaped, with 5 linear acute segments which are about the length of the tube. Native of the Bahama islands, where it is called by the inhabitants "Seven years apple."

G. tetrasperma, Roxb., Flor. Ind., ii., p. 555. *Gardenia*, No. 3, Hardwick in As. Res., vi., p. 354. An unarmed shrub, 2 feet in height, leaves obovate-cuneated, smooth. Flowers axillary, solitary, greenish-yellow, fragrant, with a long tube which widens upwards and is partly closed about the middle by a ring of silky down; calycine segments 5, subulate; limb of corolla 5-parted; berry round, 4-seeded. Native of the East Indies, on the mountains near Shreenugur.

G. Thunbergii, Lin. *fil.* suppl., p. 162. Thunb., Dissertatio ad Gardenia, No. 3. Bot. Mag., t. 1,004. Syn. *Thunbergia Capensis*, Lontin, Handlinger svenska vetenscaps, 1,773, t. 11. *G. verticillata*, Lam. Dic., ii., p. 607. *G. crassicaulis*, Salisbury, Paradisus, Londinensis, t. 46. Sonnerat, Voyage á la Nouvelle Guinée and aux Indes Orientales, t. 17-18. Journal de Physique, iii., p. 299, t. 3. An unarmed shrub of 3 or 4 feet in height. Leaves elliptic, acute, glabrous, opposite or 3 or 4 in a whorl. Flowers large, white, fragrant, terminal, solitary, sessile, 8-parted; limb of calyx tubular, cleft laterally; segments dilated at the apex. Berry ovate, 1-celled. Native of the Cape of Good Hope and the island of Manilla.

G. Rothmannia, Lin. fil. supp., p. 165. Thunberg, Dissertatio ad Gardenia, No. 6. Bot. Mag., t. 690. Syn. *Rothmannia Capensis*, Thunberg, Handlinger svenska, 1776, p. 65, f. 2. An arboreous, unarmed shrub, 5 to 10 feet high, native of the Cape of Good Hope. Leaves oblong, acute, glabrous, on very short petioles, having glandular hairs on the axils of the veins beneath. Flowers axillary and almost terminal, solitary, white, spotted with

red, fragrant, sessile, 5-parted and pentandrous: calyx ribbed, having the segments subulate, terete and erect: corolla with an abconical tube, a campanulate throat and spreading, acute segments. Berry 2-celled.

G. montana, Roxb., Fl. Ind., ii., p. 556. An arboreous spiny shrub; native of the East Indies, among the Circar mountains. Bark white, soft and spongy. Spines opposite, short, acute, stiff. Leaves oblong, obtuse, almost sessile, downy beneath, with revolute edges, deciduous in December, 3 inches long and 2 inches broad, smooth and shining above. Flowers rising 3 to 5 in a fascicle from the buds, on short pedicels; rather large, fragrant, when first open white, but soon becoming more or less yellow. Limb of calyx usually 5-toothed. Corolla 5- to 7-cleft, stamens enclosed. Nectary a moniliform fleshy ring, surrounding the insertion of the style. Berry drupaceous, about the size of a pullet's egg, ash-coloured and yellow mixed. Seeds imbedded in the pulp.

G. densa, Wallich, in Roxb., Flor. Ind., ii., p. 559 (very nearly allied to *G. tetrasperma*). A spinose shrub of 4 or 5 feet in height, with numerous decussate branches spinose at the apex; native of Nepal, on the southern face of Sheopore, above Thoka. This is a doubtful gardenia, and is hereafter described as *Randia tetrasperma*.

G. Devoniana, Bot. Reg., 1846, p. 63. This glorious plant is a native of Sierra Leone. The flowers are of gigantic size, pure white at first, but afterwards changing to light straw-colour. They look much like those of a huge white lily and are highly odoriferous.

Randia.

The species of this genus of *Cinchonaceæ* are small trees or shrubs, natives of the tropical regions of both hemispheres. They have axillary spines, and as regards the construction of their flowers are very nearly allied to *Gardenia*. The main differences are in the ovary, which is 2-celled and surmounted by a disc. The fruit has a dried rind, is surmounted by the limb of the calyx, and is internally divided into two compartments containing numerous seeds imbedded in pulp. Moreover, the tube of the corolla is usually shorter in this genus than in *Gardenia*. There are about 90 species, all tropical; many of them very fragrant, the most

noticeable of which are:—*R. dumetorum*, Lam. Ill., t. 156, f. 4. Syn. *Canthium coronatum*, Lam. Dic., i., p. 602. *Gardenia dumetorum*, Retz. Obs., ii., p. 14; Roxb. Cor., t. 136. *Gardenia spinosa*, Lin. fil. suppl., p. 164. *Randia spinosa*, Blum. Bijd., p. 981. *Posoqueria dumetorum*, Roxb. Fl. Ind., ii., p. 564. *Gardenia spinosa*, Thunberg, Dissertatio ad Gardenia, No. 7, t. 2, f. 4. *Ceriscus Malabaricus*, Gærtn. Fruct., i., t. 28. A thorny shrub of 6 to 10 feet in height, native of the East Indies, frequent on the seashore. It is much employed for fences in its place of natural growth. Thorns opposite. Leaves oval, bluntish, cuneated at the base, glabrous. Flowers sessile, solitary, almost terminal, white, clothed on the outside with adpressed villi, fragrant; limb of calyx 5-parted, with oblong lobes, which are a little shorter than the corolla. The branches are downy while young, but afterwards glabrous. Berry almost globose, about the size of a small apple, 2-celled, and crowned; cells many-seeded. The fruit bruised, and thrown into ponds, very soon intoxicate the fish, which then float to the surface and are easily taken. It is not thought that the fish are rendered unwholesome by the effects of the fruit.

R. uliginosa, D.C., Prodr., iv., p. 386. Syn. *Gardenia uliginosa*, Retz. Obs., ii., p. 14; Rox. Cor., t. 135. *Posoqueria uliginosa*, Roxb., Fl. Ind., ii., p. 563. A thorny shrub of 5 to 8 feet in height. Thorns almost terminal, opposite; branches tetragonal. Leaves 2 to 3 inches long, 1½ inch broad, oblong, somewhat cuneated. Flowers 1, 2 or 3 at the tops of the branchlets, large, white and fragrant, sessile; limb of calyx tubular, almost entire, a little shorter than the tube of the corolla, which is villous in the throat. Berry size and shape of a pullet's egg, ash-coloured or olive grey; 2-celled. Seeds flattish, nestling in the pulp. Native of the East Indies, delighting in moist places, such as the banks of rivers, lowlands, &c.

R. longispina, D.C., Prodr., iv., p. 386. Syn. *Posoqueria longispina*, Roxb., Fl. Ind., ii., p. 566. A shrub of 5 to 6 feet in height, with opposite or alternate, horizontal, sharp thorns, from 1 to 2 inches long. Branches long, dependent. Leaves obovate-cuneated, smooth; on the young shoots opposite, on the old ones in fascicles; stipules subulate. Flowers axillary and almost terminal, solitary, on short pedicels, large, pure white and fragrant; tube of calyx cylindrical, 5-lobed, lobes ovate-cordate, permanent;

corolla villous on the outside. Berry obovate, smooth, size of a nutmeg; seeds immersed in the pulp. Native of the coast of Coromandel.

R. nutans. D.C., Prodr, iv., p. 386. Syn., *Posoqueria nutans*, Roxb., Fl. Ind., ii., p. 565. *Ceriscus Malabaricus*, Gærn., Fruct., i., t. 28. A shrub of 3 to 4 feet in height with slender, opposite, spreading thorns and long dependent branches which are pubescent while young. The leaves are on short petioles, opposite on the young shoots, but fascicled on the old ones, narrow-obovate-oblong, from 1 to 2 inches long by about 1 broad. Flowers solitary, on short peduncles, under the spines, medium sized, white, fragrant; corolla silky on the outside, throat villous. Berry globuse, size of a nutmeg, 2-celled, crowned by the tube of the calyx, which is entire. Native of the East Indies.

R. Floribunda, D.C., Prodr., iv., p. 336. Syn., *Posoqueria floribunda*, Roxb., Fl. Ind., ii., p. 596. A large stiff-branched shrub, growing in a good soil to a small tree. Thorns axillary, stiff. Leaves opposite and in fascicles, obovate-cuneated, smooth. Flowers disposed in lateral fascicles, on short pedicels, medium-sized, white at first but soon becoming yellow, fragrant; corolla silky outside, segments obovate. Berry ovate, cordate, polished, size of a prune, 2-celled, many-seeded, crowned. Native of the Coast of Coromandel.

R. longiflora, Lam. Dic., iii., p. 26, Ill., t. 156, f. 3. Syn., *Posoqueria longiflora*, Wall., in Rox. Fl. Ind., ii., p. 568. *Gardenia multiflora*, Willd., Spec., i., p. 1231. *Posoqueria multiflora*. Blume, Bijdr., p. 980. An arboreous shrub, native of Chittagong, where it grows as a rather large tree. Thorns opposite, recurved. Leaves 6 inches long by 1½ to 2 inches broad, lanceolate-oblong, smooth. Flowers large, pale or nearly white when they first expand, becoming yellow by the second day, fragrant; corymbs terminal and axillary, 11- to 13-flowered; limb of calyx tubular, 5-lobed; lobes semilunar; tube of corolla long and slender. Berry the size of a cherry, yellow when ripe, smooth, fleshy.

R. fasciculata, D.C., Prodr., iv., p. 386. Syn., *Posoqueria fasciculata*, Roxb., Fl. Ind., ii., p. 568. *Gardenia fasciculata*, Roxb., Hort. Beng., p. 15. *Webera fasciculata*, Kurz., For. Fl., ii., p. 49. A spreading shrub of 4 to 5 feet in height, armed with straight axillary thorns. Leaves 1 to 5 inches by ½ to 1½ inch, ovate-oblong,

almost sessile, smooth, base rounded or narrowed, petiole short, stipules narrowly lanceolate. Flowers fascicled, nearly sessile, axillary and in forks at the branches; calyx hairy, with 5 subulate lobes. Flowers white at first, but in the course of a few days changing to a pale yellow colour; fragrant; segments of corolla oblong; stigma large, fusiform. Berry purple, size of a pea, cells about 6-seeded. Native of the tropical Himalaya, from Nepal to Bhotan, ascending to 4000 feet, Khasia mountains, Assam, Silhet, and Tenasserim.

R. rigida, D.C., Prodr., iv., p. 386. Syn., *Posoqueria rigida*, Roxb., Fl. Ind., ii., p. 570. A strong, rigid shrub of 6 feet in height, with tetragonal villous branches. Thorns opposite, super-axillary, each having an annular joint, rarely two above the middle, the lower half downy, the upper smooth and shining. Leaves ovate, smooth, in approximate fascicles, each ending in a cuspidate point. Flowers by threes, axillary and almost terminal, white and fragrant; tube of corolla, long, slender. Berry purple, downy, 2-celled, many-seeded. Native of the valley of Nepal and the surrounding mountains, also at Noakote.

R. armata, D.C., Prodr., iv., p. 387. Syn., *Mussænda spinosa*, Lin., Mantissæ, p. 45, also Jacquin, Stirpium Americanarum Historia, t. 49. *Gardenia armata*, Swartz., Flor. Ind. Occ., p. 524; *Gardenia tetracantha*, Lam. Dic., ii., p. 609. A thorny shrub of 6 to 10 feet high. Thorns 4 together at the tops of the branchlets, short and spreading. Leaves ovate, acute at both ends, glabrous or downy. Flowers pure white, fragrant, usually 4 on the tops of the branchlets on short pedicels; lobes of calyx linear-cuneiform; tube of corolla long, cylindrical, glabrous. Native of Carthagena, Martinique, St. Lucia, &c., in woods.

R. tetracantha, D.C., is very similar to the preceding, but has flowers double the size. It is a native of Mexico, about Acapulco and Regiomonti. It is figured by Cavanilles, Icones Plantarum in Hispania, v., p. 20, t. 435.

R. ferox, D.C., Syn., *Gardenia ferox*, Chamisso and Schlechtendal in Linnæa, iv., p. 198. A shrub of 4 to 5 feet in height, with decussate, spreading, acute thorns. Leaves ovate or oval, glabrous above and pubescent beneath; stipules pellucid. Flowers white, fragrant, disposed in cymose fascicles; tube of calyx turbinate,

but the limb is acute and 5-cleft beyond the middle; segments of corolla almost orbicular. Native of Brazil, at Rio Padre.

R. capitata, D.C. A shrub of 4 to 6 feet in height, armed with stiff, short thorns, 4 at the top of each branchlet; leaves ovate, acute, hairy on both surfaces as well as on the branchlets. Flowers sessile; 6 to 8 in a capitate fascicle at the tops of the branchlets: limb of calyx tubular, with stiff subulate teeth; tube of corolla 3 times longer than the segments, villous on the outside. Flowers white, sweet scented. Native of Mexico.

R. malabarica, Hooker and Thomson, Flor. Brit. Ind., iii., p. 111. Lam. Dic., iii., p. 25. Syn., *Gardenia fragrans*, Koen., Rox. Cor., t. 137; Wall. Cat., 8267; *Posoqueira fragrans*, Koen., in Roxb., Fl. Ind., i., p. 717: *Stylocoryne Pandaki* and *S. Malabarica*, D.C., Prodr., iv., p. 377: *Griffithia fragrans*, W. & A., Prodr., p. 400: Wight, Ic., t. 310. *Canthium parviflorum*, Schlecht., in Herb. Hohen., No. 816. An erect shrub, native on the hills from Canara southwards, also Ceylon; not uncommon up to 3000 feet. The young shoots are unarmed, as is the whole plant when growing in a rich soil; otherwise it has straight spines. Leaves 1 to 2½ inches in length, coriaceous, elliptic, obovate or oblong: stipules small, triangular. Cymes short, sub-sessile, glabrous or puberulous. Flowers fascicled, few- or many-flowered. Corolla ½ to ¾ inch diameter, corolla-tube shorter than the lobes. Berry size of a pea; seeds rough. Ceylon specimens have more elliptic leaves, looser cymes, larger flowers, and more acute buds.

R. Humboldtiana, D.C. Syn. *Mussaenda pubescens*, Humboldt and Bompland, Nova plantarum genera, iii., p. 410: *Gardenia Humboldtiana*, Rœmer et Schultes, Systema vegetabilium, v., p. 243. A shrub of 5 to 10 feet in height. Native of the shores of the Pacific, near Guayaquil. Branches nearly terete, glabrous, furnished each with 2 spines at the apex. Leaves elliptic, short-acuminated, pubescent, membranous. Flowers white, odorous, 3 to 5 together, terminal, pedunculate: corollas pubescent.

R. nitida, D.C. A shrub of 5 to 6 feet in height. Native of New Granada near Turbaco. Branchlets rather angular, furnished with 2 spines at the apex. Leaves elliptic, acute, glabrous, shining. Flowers terminal, twin or by threes or fours, white, fragrant, sessile: corollas glabrous.

R. macrantha, D.C. Syn. *Randia longiflora*, Salisbury, Paradisus Londinensis, t. 93. *Gardenia longiflora*, Ait. Hort. Kew, Ed. 2, i., p. 368. *Gardenia macranthra*, Rœmer et Schultes syst., v., p. 235. An unarmed shrub, 5 to 6 feet high. Leaves ovate-oblong, acuminated, rather ciliated. Flowers sessile, almost terminal, 6 to 7 inches long, cream-coloured, fragrant; 5-parted: lobes of calyx subulate, spreading. The long tube of the corolla is dilated at the apex. The segments are revolute. Ovarium 2-celled. Native of Sierra Leone.

R. tetrasperma, Hooker and Thomson, Flor. Brit. Ind., iii., p. 109. Brand. For. Fl., p. 272. Syn. *Gardenia densa*, Wall., in Rox. Fl. Ind. Ed., Carey and Wall., ii., p. 559. *G. tetrasperma et densa*, D.C. Prod., iv., p. 383. An erect rigid bush, 6 feet in height, branches woody, spinescent. Bark rough. Leaves elliptic or obovate, glabrous, narrowed into the short petiole: stipules small, triangular-subulate. Flowers sub-solitary, sessile, greenish-white, fragrant, $\frac{1}{4}$ inch in diameter; calyx-tube terete, hardly produced above the ovary, corolla tube very short ($\frac{1}{8}$ of an inch long), lobes oblong; anthers exserted; stigma spindle-shaped. Berry globose, $\frac{1}{4}$ inch diameter, 4-seeded. Native of the sub-tropical Himalaya, from Kashmir eastwards, ascending to between 4,000 and 6,000 feet in Kumaon, and to 7,000 feet in Sikkim and Bhotan. It also occurs in Assam and Silhet.

R. exaltata, Griff. Notul., iv., p. 262. Kurz. For. Fl., ii., p. 46. Syn. *Gardenia pulcherrima*, Kurz. in Journ. As. Soc., 1872, ii., p. 312; 1877, ii., p. 155; For. Flor., ii., p. 43. A glabrous, erect, unarmed tree, 50 feet in height; trunk slender, branches with pale bark, youngest compressed and pubescent. Leaves 4 to 7 inches long by 2 to $3\frac{1}{2}$ inches broad, coriaceous, elliptic or elliptic-lanceolate, acute or sub-acute; petiole short, stipules broadly triangular. Cymes axillary or leaf-opposed, pubescent. Calyx tomentose, teeth irregular. Corolla very large, white, sweet-scented, 3 inches long; tube short, limb inflated, $1\frac{1}{2}$ inches across the broad ovate lobes. Anthers slender, included. Style filiform. Stigma included, clavate, 2-lobed. Berry globose, 1 to $1\frac{1}{2}$ inch diameter, woody, many-seeded; pericarp smooth. Seeds imbedded in pulp, $\frac{1}{2}$ inch across, much compressed, obtusely angled, smooth or wrinkled. Native of Tenasserim, Mergin in mangrove swamps and Andaman Islands.

R. macrophylla, Br. in Wall. Cat, 8304 (Rothmannia). An erect, unarmed shrub, 3 to 4 feet high; branches few, 2-leaved at the top. Leaves 10 to 12 inches long by 2 to 3 inches broad narrowly elliptic-oblong or oblong-lanceolate, acuminate, coriaceous glossy above, with pubescent mid-rib and strong arched nerves beneath, base acute or obtuse, petiole very short, stout, hispid; stipules long-subulate from a broad triangular base. Flowers 1 to 2 subterminal. Calyx tube oblong, lobes 1 inch, linear, erect, hairy. Corolla white with purple spots in lines on the throat, 4 to 6 inches across, fragrant. Anthers very long. Stigma clavate, notched. Native of Malacca, Penang and Singapore.

Aglaia.

A genus of *Meliaceæ*, consisting of about fifty species, natives of China, and the Malay and Pacific Islands, and India: one being found in North Australia, New Caledonia and New Guinea. They are trees with alternate trifoliate or imparipinnate leaves and very small flowers borne on branched axillary panicles.

A. odorata, Loureiro, Flor. Cochin-Chinensis, p. 173; Wight Icones, ii., t. 511: Jussieu in Mém. du Museum d'histoire naturelle, xix., t. 14, f. 7. Syn. *Communium sinense*, Rumph., Amb., v., t. 18, f. 1. *Communium Chinense*, Roxb., Hort. Beng., p. 18; Fl. Ind., i., p. 636. *Opilia odorata*, Sprengel, Syst. Veg., i., p. 766. An elegant shrub or small leafy tree, native of the eastern peninsula of India, Malacca, Penang and Singapore; distributed in Siam, Java and China, also cultivated in Ceylon. In China it is called *Lan-wha* and *Yu-chu-lan*, and is valued for its flowers, which are used for scenting tea and in the composition of Jos-stick, which is used for burning in religious ceremonies. (See Series i., p. 86.) The extremities of the young shoots of this tree are covered with stellate ferruginous scales. Leaves 2 to 6 inches long, glabrous, or quickly becoming so. Leaflets obovate or oblong-obtuse, shortly petiolate, terminal one longest, base cuneate. Panicles rather lax. Flowers on slender pedicels, yellow, very fragrant, $\frac{1}{12}$ inch diameter; they retain their fragrance when dry. There is no doubt that the exquisite perfume of Aglaia could be secured by the processes of maceration and enfleurage, and it is very probable that its essential oil could be extracted by distillation. It is also

a flower well adapted to the process now known as "exhaustion by solvent." (See "Concrete essences," Series i., p. 63.)

Amoora.

A genus of *Meliaceæ*, consisting of about 15 species occurring in India and the Malay Archipelago.

A. decandra, Hooker and Thomson, Flora Brit. Ind., i., p. 562. *Aglaia* (?) *decandra*, Wallich in Roxb., Flo. Ind., Ed. Carey, ii., p. 427. Syn. *Sphærosacme fragrans*, Wall., l. c., p. 429. *Lansium* (sp.), W. and A., Prodr., i., p. 119. A large spreading tree with thick trunk, native of Nepal and Sikkim at altitudes of 2,000 to 4,000 feet, and Malay peninsular. Leaves about 1 foot long by 1 to 2 inches wide; petioles short. Male panicles equalling the leaves. Flowers very fragrant, on slender pedicels; petals 5; sepals very short: anthers 10. Fruit globose-ovoid, 5-celled and 5-seeded.

Hovenia.

A genus of *Rhamnaceæ*, near allied to *Ceanothus*, from which it is easily recognised by the short foot-stalks of the minute, whitish flowers (which are in axillary or terminal forked panicles) becoming much thickened after the flower withers. One species only is known, *H. dulcis*, which is distributed over China, Japan and the Himalayas. It is found from Chamba and Hazara to Bhotan. Thunberg, Flor. Jap., p. 101; Lam. Ill., t. 131; Sieb., Fl. Jap., t. 73 and 74: Bot. Mag., t. 2360; Bot. Reg., t. 501; D.C., Prod., ii., p. 40. A tree of 20 feet in height, with a straight trunk and broad rounded head. The leaves are alternate, heart-shaped, deeply and sharply serrated, 4 to 6 inches long by 2 to three inches wide. Flowers in pedunculated, dichotomous, many-flowered axillary and terminal cymes. This tree is extensively cultivated in China and Japan for its sweet fleshy peduncles, which taste like a Bergamot pear.

Hopea.

A genus of *Dipterocarpaceæ*, consisting of resin-bearing trees, natives of Borneo, whose flowers differ from those of *Shorea* only in the number and disposition of the stamens. As general

characters of the genus the calyx is of 5 sepals, 2 of which are extended into wings; corolla 5-cleft, convolute in æstivation. Stamens 10, inserted in the throat of the corolla, alternate ones bearing each 2 anthers. Anthers short. Fruit of a tender texture, 1-celled, 1-seeded. The trees are large, with terminal panicles of small, fragrant, yellow flowers.

H. odorata, Rox., Cor., iii., p. 9, t. 210. A tree of about 80 feet in height; native of Chittagong. Leaves on short stalks, ovate-oblong, shining, bifarious, waved, smooth, of a deep green on both sides, having often on the under side a rather large single gland in the axils of the large veins. Stipules subulate, falling off at a very early period. Panicles terminal, and from the exterior axils, drooping, composed of alternate, bifarious, secund, recurved, villous ramifications of numerous small, pale yellow, very fragrant flowers.

Stephanotis.

The few species of this genus of *Asclepiadaceæ* are natives of Madagascar. They are sinistrose climbing shrubs with smooth coriaceous leaves and beautiful white, fragrant, pedicellate flowers in interpetiolar umbels. The calyx is 5-leaved; the corolla salver-shaped, with a tube somewhat swollen at the base and a limb with 5 oblique segments; the staminal corolla composed of 5 erect, simple, short, acuminate leaves: the anthers terminated by a membrane; the stigma conical and entire or obscurely 2-lobed; and the 2 follicles thick, horizontal and acuminate, containing many comose seeds. The species preferred is the *S. floribunda* (Bot. Mag., t. 4058). Few white flowers equal this in wax-like purity, gracefulness of form and delicacy of perfume. It is easily propagated by means of cuttings made of the young wood, leaving a heel of old wood at the base. The young plants grow freely if planted in good fibrous loam, crocks, and leaf-mould, to which sufficient coarse sandstone grit has been added to keep the whole fresh and open. In a compost of this kind, the growth made is short-jointed and robust, and much more floriferous than coarser growth made by plants in well-manured composts. It is much grown as a stove plant in England, but under glass it is very apt to become infested with mealy bug, and, although sending out very long shoots, does not attain the enormous length of plants growing in hot climates, nor do the flowers attain such power of perfume.

Schubertia.

Schubertia graveolens, Lindley, Bot. Mag., t. 3891, Bot. Reg., t. 1846. Native of Brazil and found in several parts of tropical South America. The genus *Schubertia* belongs to the same Natural Order as Stephanotis, *Asclepiadaceæ*, with which it is equal in beauty, the flowers being rather larger, quite as fragrant and likewise produced in great profusion. The several species of Schubertia are twining, hairy and milky shrubs with opposite leaves, which are variable in form, being sometimes obtuse, sometimes acuminate. The large fleshy flowers are produced in handsome umbels. The calyx is deeply 5-parted ; the corolla funnel-shaped, the tube swollen below, and the limb divided into 5 linear spreading lobes : the anthers are terminated by a short membrane. The pollen-masses are obovate, compressed and pendulous and the stigma turbinate.

Sterospermum.

Sterospermum is a genus of *Bignoniaceæ*, embracing about a dozen species, all of which are confined to tropical parts of Africa and Asia. They are all trees with imparipinnate leaves and terminal panicles bearing generally white, often highly fragrant flowers. The almost bony, scarcely winged seed, attached to the very corky septum of a cylindrical or almost square capsule, together with a cup-shaped calyx and almost bell-shaped corolla, at once distinguish the genus from all others of the order to which it belongs.

Sterospermum suaveolens is frequent throughout the moister parts of India. Its vernacular name in Hindustanee is Pád, Páral and Káshta-pátali. In Bengalee it is known as Párul. The flowers in South India are known as Madana-Kama-pu. This tree is the Pátalá or Pátali of Sanskrit writers,* its flowers are said by the poets to so intoxicate the bee, that he is unable to distinguish one flower from another. In the Nighantas, the tree bears, among other synonyms, those of Káma-duti (Cupid's Messenger), Madhu-duti (Messenger of Spring) Stahli, Ambu-vásini and Tamra-pushpa (red-flowered). Pátalá also signifies "light red" or "rose-coloured."

* Pharmacographia Indica, iii., p. 20.

The tree is botanically described by Roxburgh (Flor. Ind., iii., p. 104) as *Bignonia suaveolens.* A middle-sized tree, native of Bengal and the Eastern parts of the Coromandel Coast. Flowering time, the hot season: trunk tolerably erect, though not straight; bark ash-coloured and somewhat scabrous. Leaves opposite, pinnate, with an odd one, from 12 to 24 inches long. Leaflets opposite, from 2 to 4 pairs, oval, with long bluntish, narrow points, slightly serrate, having both sides downy while young, and when full grown not downy and feeling harsh; the exterior pair and odd one about 6 inches long by 3 or 4 broad; the inferior pair or pairs smaller. Petioles swelled at the base, roundish, when old, scabrous. Panicles terminal, composed of a few spreading branchlets, the first and second pairs thereof opposite; the superior dichotomous, with a solitary pedicelled flower in the forks; all are downy, and somewhat viscid. Flowers large, of a dark, dull crimson colour, *exquisitely fragrant.* Calyx campanulate; border 4-cleft, upper divisions with two minute points, outside a little villous. Corol, throat ample, woolly, convex above, flat and plaited beneath. Border, the upper divisions shorter, erect; the three inferior ones longer and projecting, with the margins of all much curled. Filaments 4, fertile, and between them a small sterile one. Anthers twin. Germ oblong, elevated on a glandular receptacle. Stigma 2-lobed.

Sir William Jones* gives the following description of the flowers:—"Corolla externally light purple above, brownish purple below, hairy at its convexity: internally dark-yellow below, amethystine above, *exquisitely fragrant*; preferred by bees to all other flowers, and compared by the poets to the quiver of Kámadéva (the Indian Cupid)." He adds:—"The whole plant, except the root and stem, very downy and viscid. The fruit can scarce be called a 'silique,' since the seeds are nowhere affixed to the sutures; but their wings indicate the genus, which might properly have been *Pterospermum*; they are very hard, but enclose a white, sweet kernel, and their light coloured summits with 3 dark points give them the appearance of the winged insects." He says, "Before I saw the fruit of this lovely plant, I suspected it to be the *Bignonia Chelonoides,* which Van Rheede calls Pádri, and I conceived that barbarous word to be a corruption of Pátali, but

* Asiatic Researches, iv., p. 289.

the pericarp of the true Pátali, and the form of the seeds differ so much from the Pádri, that we can hardly consider them as varieties of the same species, although the specific character, exhibited in the supplement of Linnæus, corresponds very nearly with both plants. The Pátali blossoms early in the Spring, before a leaf appears on the tree, but the fruit is not ripe till the following winter." For Figure, see Wight's Icones, t. 1342.

Bignonia chelonoides, above referred to by Sir William Jones is the *Stereospermum chelonoides*, D.C., figured in Wight, Icones, t. 1341; Bedd. Fl. Sylv., t. 72: Rheede, Hort. Mal., vi., 26. It is also an inhabitant throughout the moister parts of India and has very fragrant flowers. Its vernacular name in Hindustani is Pádri. In the Concan and Malabar, where *S. suaveolens* is not found, this tree is used as the Pátalá of the Nighantas: *i.e.*, the bark, flowers and root are used medicinally. *Vide* Van Rheede. Ainslie, Mat. Med., ii., p. 272, says: "This pleasant tasted root, as well as the fragrant flowers of the tree, the Vytians prescribe in infusion as a cooling drink in fevers."

Roxburgh, Flor. Ind., iii., p. 106, describes the tree botanically as follows:—

A native of the mountainous parts of the coast of Coromandel, where it grows to be a large tree. Flowering-time during the hot and rainy seasons. The seed ripens in December and January. Trunk very straight, of a great height and thickness. Bark thick, scabrous, brown. Branches very numerous, the inferior horizontal above, gradually becoming more and more erect to the top; leaves opposite, pinnate, with an odd one, about 20 inches long: leaflets opposite, short petioled, generally four pair, the inferior smallest, obliquely oval, pointed, sometimes slightly notched about the margins, when young downy, afterwards smooth, about 4 inches long by 2 broad: petioles about 9 inches long, channelled, smooth: stipules none: panicles terminal, the larger ramifications decussate, the smaller or terminal 2-forked, with a sessile flower in the cleft: peduncles and pedicels round, covered with oblong, grey, scabrous specks; bracte small, caducous: flowers large, yellow, *very fragrant*: calyx 5-notched: nectary, a yellow, fleshy ring surrounding the base of the germ: filaments, there is a fifth sterile, one between the lower pair: anthers double, stigma 2-cleft: silique very long, slender, twisted: receptacle of the seeds spongy.

white, with alternate notches on the sides for the seeds to lodge in.

Bignonia quadrilocularis, Roxb. Fl. Ind., iii., p. 107, and Rox. Cor., t. 2, is described by Roxburgh as a large tree, native of the Circar Mountains, with a straight trunk of considerable height, having a grey bark with a few scabrous spots. The branches are numerous, spreading and forming a large circular head. Leaves about the extremities of the branchlets, generally 3-fold, unequally pinnate, from 12 to 24 inches long. Leaflets from 4 to 5 pairs, opposite, oblong, serrate, acute, smooth. Stipules none. Panicles terminal, erect, large, dense, many-flowered, very downy. Bractes, scarcely any. The flowers, which appear during the beginning of the hot season, are large, rose-coloured and delightfully fragrant. The distinctive peculiarities of the construction of the flower are detailed by Roxburgh in the works quoted.

Bignonia xylocarpa, Roxb., Fl. Ind., iii., p. 108. Syn. *Stereospermum xylocarpum*, Wight (Wight Ic., t. 1335-6; Bedd. Fl. Sylv., t. 70). A tall, elegant tree, native of the forests of Western India from Khandesh to Malabar. It was first observed by Dr. Andrew Berry in Sunda and was introduced by him into the Royal Botanic Garden at Calcutta, when in 6 years the young trees were about 20 to 25 feet high. They blossom in March, April, May and June, and the seed takes about one year to to ripen. The trunk is very straight; bark ash-coloured, rather spongy and considerably cracked. Branches few and spreading but little. Leaves opposite, bi- and tri-pinnate, from 1 to 4 feet long; in Bengal they are deciduous in the cool months of December and January and appear with the flowers in April and May. Leaflets short-petioled, from semi-cordate to obliquely oblong, entire, pointed, hard and void of pubescense, from 2 to 5 inches long. Petioles common and partial, channelled and scabrous, with numerous elevated grey specks. Panicles terminal, ramifications thereof opposite or tern, 2, 3 or more times dichotomous, with a single flower in the forks, slightly pubescent. Bractes ovate-oblong, solitary on the outside of the divisions only. Flowers large, white with a tinge of yellow and delightfully fragrant. The analysis of the flower is minutely described by Roxburgh.

The natives, by a rough process of the same nature as that by which tar is obtained from pine wood, extract from the wood of

this tree a thick fluid of the colour and consistence of Stockholm tar, which they use as a remedy for eruptions on the skin. Two globular earthen pots are used, the upper is filled with chips of the wood; it has a perforated bottom and is fitted with a cover, and is luted to the mouth of the lower pot. Cow-dung cakes are then piled up round the two pots and set fire to. The tar condenses in the lower pot. It has the odour, colour and consistence of Stockholm tar.

Bignonia suberosa, Roxb., Flor. Ind., iii., p. 111; Syn. *Millingtonia Hortensis*, Willd., iii., p. 382. Respecting this species, Roxburgh observes: "The native country of this beautiful tree I have not been able to discover, but some plants or seeds were brought from the Rajah of Tanjore's garden to Madras, from thence one plant was procured for the Botanic Garden at Calcutta. It blossoms about the close of the rains, and the seed ripens in March." Its flowers are numerous, large, pure white, and delightfully fragrant. Minute botanical details are given by Roxburgh in his Flora Indica.

Limnophila.

Limnophila gratioloides, Br., Rheede, Hort. Mal., ix., t. 85, and xii., t. 36, is a small aquatic plant belonging to the Natural Order *Scrophularineæ*, and common throughout India, in swamps. It is known in Sanskrit as Ambu-ja, "water-born"; also Amra-gandhaka, "having an odour of mangoes." The Bengal name signifies "camphor." The odour of the fresh plant is remarkably refreshing and agreeable, calling to mind a mixture of camphor and oil of lemons. Roxburgh, under the name of *Columnea balsamea*, describes the plant and notices its grateful odour and aromatic taste. Its uses for medicinal purposes by the Hindus are mentioned by Dymock in "Pharmacographia Indica," iii., p. 7.

Limnophila gratioloides, Rheede, Hort. Mal., x., t. 6, bears the same vernacular names, and has very similar properties to the above.

Osmanthus.

Osmanthus fragrans, Loureiro, Coch., p. 29; better known as *Olea fragrans*, Thunb., Flor. Jap., p. 18, t. 2; Bot. Mag., t. 1552.

This shrub, belonging to the Natural Order *Oleaceæ*, is a native of Japan, China and Cochin-China, where it is much cultivated for the sake of its very sweet-scented flowers called "Kwei Hwa," which are put into teas to flavour them. It forms a shrub of 6 to 10 feet in height, with trichotomous branches and branchlets. The leaves are 2 inches long, elliptic-lanceolate, a little serrated, acuminated, shining above and pale beneath. The flowers are yellowish-white, axillary and lateral, aggregate from scaly buds; pedicels 1-flowered. This shrub is hardy enough to live in the South of England, provided it be planted in a sheltered situation, and on a slope to the south or west; or, to afford protection from north and east winds, it may be treated as a wall shrub. Young plants so placed out should have been grown for a considerable time in a cool temperature, and should be not less than 5 to 6 years old, and about 3 to 4 feet high. The soil should be light loam, with a dry sub-soil.

Evodia.

A genus of small rutaceous trees or shrubs, mostly natives of tropical New Holland and the Indian Archipelago. The leaves are opposite, sometimes simple, sometimes trifoliate on the same branch, full of pellucid dots. The flowers are minute, and disposed in oblong axillary panicles, and the flower-stalks are jointed in the middle. The petals of the flower are four-fold, and shorter than the sepals; the calyx persistent; the petals and stamens inserted at the base of a cup-shaped sinuous disc, which encircles the lower part of the four ovaries; the styles are four, becoming after a time fused into one. The fruit consists of 4 capsular, 2-valved, 1-seeded carpels, but usually fewer than 4 from abortion. The different species are sweet-scented, as implied by the generic name *ευοδια*.

E. Hortensis, Forst. Gen., p. 14, t. 7; Juss. Mém., xii., p. 485, t. 22, No. 28. A shrub of six feet in height, native of the Friendly Islands and the New Hebrides. Leaves simple or trifoliate; leaflets lanceolate, pubescent as well as the branches; panicles longer than the petioles or leaves. Used by the natives for scenting cocoa-nut oil.

E. drupacea, Labillardière, Sertum Austro-Caledonicum, p. 73, t. 75. A shrub of 6 feet in height, native of New Caledonia.

Leaflets 3, sessile, obovate-oblong, smooth. Drupe 4-seeded; corymbs axillary, dichotomous. Calyx 4-toothed. Petals 4.

Calycanthus.

Calycanthus. (Derived from *καλυξ*, a calyx, and *ανθος*, a flower, in reference to the calyx being coloured, and appearing like a corolla). The genus *Calycanthus*, giving its name to the family *Calycanthaceæ*, is composed of handsome deciduous shrubs, natives of North America, with brachiate branches, and terminal and axillary flowers rising after the leaves. The flowers are exquisitely scented, and the wood, bark, roots and leaves are generally odorous. The leaves are opposite, oval or ovate-lanceolate, entire, generally rough on the surface. The flowers are solitary stalked and made up of a great number of lurid purple, dull red or chocolate coloured narrow sepals and petals. The stamens are very numerous, inserted on the mouth of the calyx-tube, which bears on its inner hollow surface numerous achenes, each with one or two seeds.

C. Floridus is a native of many parts of the United States, particularly Carolina, and is found on the shady banks of rivulets. It is from 4 to 6 feet in height, with spreading branches. The leaves are ovate, downy beneath as well as the branchlets. Bot. Mag., t. 503. Duham, Arb., i., t. 45. Lam., Ill., t. 445, f. 1. Guimp., Abb., t. 4. Mill., Fig., t. 60.

Var. a, oblongus. Leaves oblong. Ait., Hort. Kew, ed. 2, iii., p. 282.

Var. β, ovatus. Leaves roundish-ovate. Ait., *loc. cit.*

The scent of the flowers and leaves is thought to resemble that of a sweet apple or quince. The wood and roots smell strongly of camphor, and the bark is very aromatic, being used as a substitute for cinnamon in the United States, where the plant is called "Carolina Allspice," or "Sweet-scented Shrub," but some of its varieties are almost scentless, and they vary much in the form and pubescence of the leaves as well as in the colour of the flowers. Some of these varieties have, by some authors, been considered as species, such as the following:—

C. fertiles. Walter, Flora Carolineana, p. 151. Bot. Reg., t. 404; Guimp., Abb., t. 5. Syn. *C. glaucus*, Willd, Enum., p. 359; D.C., Prodr., iii., p. 2; Bot. Rep., 539. Native of

Carolina, on the mountains. Leaves ovate-lanceolate, acuminated, glaucous and pubescent beneath. Flowers fertile ; of a lurid purple colour.

Var. β, oblongifolius, Nutt., Gen. Amer., i., p. 32. Native of North Carolina, on the mountains. Leaves ovate-lanceolate, elongated.

C. lævigatus. Willd., Enum., p. 559, and Willd., Hort. Berol., t. 80 ; Bot. Reg., t. 481 : Guimp., Abb., t. 6 ; Nutt., Gen. Amer., i., p. 312 ; Pursh, Flor. Sept. Amer., i., p. 358. Syn. *C. ferax*, Michx., Fl. Bor. Amer., p. 305. Syn. *C. Pensylvanicus.* Loddige's Catalogue ex Loudon's Hortus Britannicus, p. 214. Leaves oblong or ovate, gradually acuminated, rather wrinkled and rough to the touch on the upper surface, but glabrous and of a pale, glaucous tinge beneath. Branches strictly erect. Flowers lurid purple. Native of Pensylvania, Virginia and Carolina, on the mountains.

There are several varieties in nurseries, under the names *nanus*, *inodorous*, *Pennsylvanicus*, *asplenifolius*, *bullatus*, &c., but they are not distinct species. Possibly the only two absolute species are *C. Floridus* and *C. occidentalis*, but although the flowers of this last are more than three inches across when fully expanded, they are devoid of perfume. *C. occidentalis* is a native of California ; it differs chiefly from the Carolina plants in its long flower stalks and the cordate base of the leaves. *C. macrophyllus* is a form of this species.

C. Floridus and its varieties are often met with in English gardens. They will grow in any kind of soil, but not so freely as in peat. They usually flower from May until August. The method recommended for propagation, is to lay down the young branches in autumn, which will take about a year to root, before which time they should be transplanted ; when taken from the mother plant they should be set where they are intended to remain, for they do not bear transplanting well after they are grown to any size. When the branches are laid, they should be covered yearly with rotten tan to keep out the frost. When the layers are transplanted the ground should be covered with mulch, to prevent its becoming too dry, and watered in dry weather, but not abundantly.

Chimonanthus.

Chimonanthus (derived from *χειμων*, winter, and *ανθος*, a flower, in reference to the time of flowering, which is from December to February).

C. fragrans, the "Japan Allspice," is the only representative of this genus of the *Calycanthus* family, and it is well-known in English gardens for its early flowering and the sweet scent of its blossoms. It was introduced from China in 1766 and for a long time was known under the name of *Calycanthus præcox*, until it was shown to differ from that genus in having but ten stamens arranged in two rows; while in *Calycanthus*, they are very numerous and arranged in four rows.

Chimonanthus fragrans, Bot. Reg., 404. Syn. *Calycanthus præcox*, Lin. Spec., 718; Ait., Hort. Kew, Ed. 1, ii., p. 220, t. 10: Bot. Mag., t. 466; Lam. Ill., t. 445, f. 2. Native of Japan. It is a shrub of about six feet in height, much branched and generally treated as a wall-plant in gardens. Its leaves are opposite, stalked, between oval and lanceolate in form, acuminate, very rough on the surface, glabrous beneath; they generally fall late in the autumn, but sometimes a few remain till the spring. The flowers form in the axils of the old leaves, they are sessile on the branches, about an inch in diameter and made up of a large number of pale yellow waxy petals, arranged in several rows; the inner series in one variety chocolate-coloured and in another mottled with red.

> *Var. β, grandiflorus*, Bot. Reg., t. 451. In this the flowers are larger and much more numerous.
>
> There is also a large-flowered variety, with flowers yellow both inside and out.

The delightful fragrance of the blossom (which has been compared to a mixture of Jonquil and violet) and the little trouble required for the cultivation of this plant and its varieties, suggest the idea of its growth on a large scale for the purpose of extracting the perfume; especially as it is hardy in sheltered situations and produces such a profusion of flower. It can be grown either against a wall or on espalier, or as a bush if protected from the north; in such a position as the last it is recorded in a gardening journal that in a garden in Cork, "a tree of Chimonanthus about

7 feet high has bloomed regularly for more than thirty years without even the protection of a wall. It stands in the centre of the garden facing the south, exposed to the east and west, but sheltered from the north by a hill. It grows so rapidly that but for its being pruned every year it would cast too heavy a shade in summer, when it is thickly covered with large handsome leaves, and recently the tree reached such a size, that a large bough had to be sawn off to admit light to the other plants in its vicinity." As grown in a conservatory, a writer in the Botanical Magazine says:—"the beauty of the Calycanthus surpasses all description. The plant is 16 feet high and expands 10 feet wide. It is covered with blossoms from top to bottom and the fragrance of it may be perceived at a distance of fifty yards from the conservatory. The tree bears a succession of flowers from September to March."

The Chimonanthus thrives in almost any kind of soil and is easily propagated by seeds or layers. Young cuttings will also strike root if planted in a pot of sand with a bell-glass placed over them, in a little bottom heat; but this method is not so successful as layering.

Idesia.

Idesia polycarpa forms a genus of *Bixineæ* (*Flacourtiaceæ*), allied to *Bennettia*. It is also known in gardens as *Polycarpa Maximowiczii*, and is a large growing Japanese tree, which was unknown to Science until 1866, when it was described by the Russian botanist, Maximowicz, who met with it in cultivation at Nipon and Yedo, and ascertained that it was a native of the island of Kiusiu, at the foot of a mountain called Hikosan. He named it in commemoration of a Dutch traveller named Ides. The large, alternate leaves have long crimson stalks, and are acuminate, slightly cordate at the base, irregularly serrate, the larger ones measuring about 6 inches across, bright green above, and whitish or almost glaucous beneath, with 5 prominent branching nerves, which are reddish towards the base. The flowers are in long, terminal panicles, and spring from the axils of the upper leaves. They are diœcious and apetalous. The male flowers have from 4 to 6 yellowish-green, spreading sepals, an indefinite numberof stamens inserted on a small disc and having villose filaments (pale green in colour) and short longitudinally dehiscent, orange-coloured anthers. Each blossom is

half an inch across. The female flowers have indefinite abbreviated staminodes, and a globose ovary with about 5 parietal placentæ. The female flowers are succeeded by very numerous orange-coloured berries, which appear, from dried specimens communicated by the discoverer to the British Museum Herbarium, to be about as large as a small cherry. The berries are many-seeded, the seeds lying in pulp. The tree appears to be cultivated in Japan for its fruits. The flowers are deliciously fragrant, their odour resembling that of a *Vanda*; and although their colouring is not brilliant, their effect, combined with the red leaf-stalks, the varying green of the leaves, and their elegant drooping habit, is extremely pleasing. The plant was figured in "The Garden," 2nd Feb., 1878.

Chloranthus.

A genus of tropical *Chloranthaceæ* consisting of small, evergreen, aromatic, herbaceous plants or undershrubs, having jointed stems, tumid under the articulations, and opposite, simple leaves, with sheathing petioles and minute intervening stipules. The flowers are hermaphrodite and disposed in terminal, loose, slender spikes, fragrant. The ovary is one-celled, consisting of a single carpel with one pendulous ovule, and the seed has a large quantity of albumen, the embryo being very minute.

C. inconspicuous, Swartz, in Phil. Trans., lxxvii., p. 359, t. 15. A suffruticose plant of about one foot in height. Native of China and Japan. The leaves are ovate-oblong, obtuse, serrated, pale beneath; spikes axillary, branched, branches alternate, flowers, opposite; anther 3-lobed, middle lobe perfect and 2-celled, the lateral ones imperfect and 1-celled. This plant is considexed to be identical with *Nigrina spicata,* Thunb., Flor. Jap., p. 65.

C. officinalis, Blume, Enumeratio Plantarum Javæ, i., p. 79, and Flor. Jav., p. 10, t. 1. A shrub of 3 to 4 feet in height. Native of Java, in high mountain woods. Leaves oval-oblong or lanceolate, the superior ones more acuminated than the rest. Spikes branched, terminal; anther 3-lobed, middle lobe perfect and 2-celled, lateral ones imperfect and 1-celled. The whole plant has an aromatic and fragrant smell. It is used medicinally by the Javanese.

C. monander, R. Brown, in Bot. Mag., under No. 2190. A

shrub of 1 to 1½ foot in height. Native of China. Spikes brachiate. Anther undivided, 2-celled, perfect.

C. elatior, R. Brown, loc. cit. A shrub of 6 feet in height, native of China and Cochin-China. Syn., *Creodus odorifer*, Lour., Coch., p. 89. Branches long, somewhat scandent. Leaves oblong-lanceolate, serrated petiolate. Spikes, slender, long, reflexed, crowded, nearly terminal. Flowers small, yellow; anther 3-lobed, the middle lobe perfect, 2-celled, the lateral lobes imperfect and 1-celled.

C. serratus, Rœm. et Schultes, Syst., iii., p. 461. Syn., *Nigrina serrata*, Thunb., Nova Acta Upsala, vii., p. 142, t. 5, f. 1. Native of the interior of Japan. A plant of about 1 foot in height. Stem simple. Leaves ovate-oblong, doubly serrated, the serratures acute. Spikes brachiate, axillary.

C. monostachys, R. Brown, in Bot. Mag., t. 2190. Lindley, Collectanea Botanica, t. 171. A shrub of 1 to 2 feet in height; native of China. Leaves elliptic, serrated, acuminated. Spikes solitary, simple. Flowers alternate, yellowish; anther incurved, 3-lobed, the middle lobe 2-celled and perfect, and the lateral lobes 1-celled and imperfect.

C. brachystachys, Blume, Flor. Jav., i., p. 13, t. 2. A shrub of 2 to 3 feet in height. Native of Java, in the provinces of Bantam and Krawang, in woods on the higher mountains. Leaves oblong-lanceolate, acuminated at both ends, serrated; spikes branched, terminal; anther undivided, 2-celled.

All the above species are called by the Chinese "Chu-Lan," and are esteemed for the rich fragrance of their flowers; it has frequently been stated that those of *C. inconspicuous* are largely used for scenting tea, but this appears to be a mistake, originating no doubt in the similarity of its Chinese name to that of *Aglaia odorata*, the Chloranthus being called Chu-Lan, and the Aglaia "Lan," or "Lan-Chu-Lan," the dried blossoms of which are sent from various parts of Kwangtung province to the Canton Market, and realise about $15 per pecul (133⅓ lbs.) They are used for scenting the "Scented Caper" of commerce. The method of scenting the teas is described at p. 86, Series i., of this Work. The "Cowslip-flavoured" tea is said to be prepared with the flowers of *Primula prænitens*,

but it is doubtful whether the perfume of these would be of sufficient power (unless it strengthens by the slight fermentation which takes place during the process). A flower having the cowslip odour in a much stronger degree, is that of *Pterocarpus erinaceus*, Poiret, the Kino tree of West Africa, a large tree belonging to the Natural Order *Leguminosæ*, native of Senegal, and common between Senegambia and Angola. Lam. Ill., p. 602, t. 4, and Lam. Dic., v., p. 728. Pharmaeographia, p. 173. Pharm. Journ., xiv. (1855), p. 55. The numerous papilionaceous flowers (formed like those of the *Cytisus Laburnum*) are of a light yellow colour, and diffuse a delicate fragrance, nearly resembling that of the Cowslip, throughout the surrounding atmosphere. The flowers expand in the months of February and March, a period when the branches are entirely deprived of leaves.

Besides the flowers already named, it is said that the leaves of *Camellia Sasanqua* are used in the preparation of some scented teas.

Camellia Sasanqua is a tree of about ten feet in height; native of China and Japan. Its leaves and flowers are much smaller than those of *C. Japonica*. The leaves dried in the shade have a very sweet smell; a deeoetion of them is used by the women in Japan to wash their hair with, and they are mixed with tea to give it a grateful odour; indeed, they are not readily distinguished from the leaves of that plant. *C. Sasanqua* is also cultivated to a great extent on aecount of the fragranee and eleganee of its flowers. The leaves are ovate-oblong, serrated. Flowers terminal and axillary, solitary, white. Branches villous. Thunb., Flor. Jap., p. 273, t. 30. Syn., *Sasanqua*, Kæmpf. Amœn., 853.

Var. α; Semi-double white, Bot. Reg., t. 12.

Var. β; Double white, Bot. Reg., t. 1091.

A species very similar to *C. Sasanqua* is the *C. Kissi* (Wallich, in As. Res., xiii., p. 429), a shrub of about seven feet in height, native of Nipaul at Narainhetty, where it is called "Kengna" by the inhabitants. In the Newar dialeet it is called "Kissi" or "Kissi-swa." The leaves of this shrub are elliptical, bluntly acuminate and serrulated. Its white, fragrant flowers appear in September; they are sessile, generally solitary, axillary and terminal, usually 4-petalled, and with 3 distinet, furrowed, woolly styles, which are about equal in length to the stamens.

C. Oleifera. (Abel, Voyage to China, p. 174, with a figure; Bot. Reg., 492; Bot. Cab., 1065). This plant very much resembles the two preceding species. It is a shrub of 6 to 8 feet in height, native of China. Leaves elliptic-oblong, acute, serrated, coriaceous, shining. The flowers are solitary, very numerous, white and fragrant. Calyces silky, deciduous. Petals 5 to 6, 2-lobed. The Chinese extract an oil from the seed by pressure, which is in very general use in the domestic economy of China. The seeds are white; to obtain the oil, they are reduced to a coarse powder, which is boiled and pressed. An oil is also extracted in the same manner from the seeds of *C. Drupifera*, Lour., Coch., ii., p. 499; this oil has a pleasant odour, and does not easily becöme rancid; it is used to anoint the hair, and for various medical purposes.

Epigæa.

Epigæa. This name, derived from the Greek words επι, upon, and γαια, the earth, is sufficiently expressive of the mode of growth or trailing habit of this genus of *Ericaceæ.* The genus is characterised by having three leaflets on the outside of the 5-parted calyx; and by the corolla being salver-shaped, 5-cleft, with its tube hairy on the inside. One of the species, *E. repens* (Lin. spec., 565), is a beautiful procumbent shrub, native of North America, from Canada to Carolina, and is found on shady rocks and in stony woods, and on the sides of hills generally about the roots of pines. It has long been known in Europe, in cultivation, as an ornamental shrub, and is very much admired for its very fragrant flowers, usually white, with a reddish tinge, and forming in dense, axillary and and terminal racemes. Bot. Rep., 102; Lam., Ill., t. 367, f. 1; Bot. Cab., 160; Plukenett, Almagistum Botanicum, t. 107, f. 1. This species will thrive only in peat soil and in shady situations. It is propagated by layers, or by separating the rooted shoots; or by cuttings, which root readily in sand, with a hand-glass over them. The species *E. cordifolia*, Swartz, Prod., p. 73, and Swartz, Flor. Ind. Occ., ii., p. 842, is a native of Guadaloupe and Cayenne. Its leaves are cordate, roundish, stiff, hispid, serrated and convex.

Matthiola.

Matthiola. This name was given in honour of Peter Andrew Matthiola (an Italian physician who died in 1577), to a genus of

Cruciferous plants, which are mostly erect herbs, and very rarely of a shrubby habit. All the species are covered with a soft, white, stellate down, sometimes they are scabrous, with pedicellate glands. The leaves are alternate, oblong, entire or sinuately-toothed. Racemes terminal. Pedicels without bracteas. Flowers purple or white, sometimes of a dark sad colour, generally sweet-scented.

M. incana is the parent of all the garden varieties of Brompton Stock. It is a native of the South of Europe, near the sea, and in England it is found wild on rocky cliffs to the east of Hastings and in the Isle of Wight. Its stem is from 1 to 2 feet in height, shrubby at the base, erect, simple or branched. Leaves lanceolate, quite entire, hoary. Siliques somewhat cylindrical, without glands. The flowers vary from single to double, from scarlet to purple, and white or even variegated with these colours ; these varieties have been designated under various names by authors before the days of Linnæus. (*Cheiranthus incanus*, Lin. spec., 924 : Weinmann, Phytanthoza Iconographica, t. 643, f. a. e., and t. 644, f. a. b.).

M. tristis. This humble plant is best known as the Night-scented Stock. It has narrow hoary leaves and dingy yellow or greenish-brown flowers, which are very sweet-scented in the evening. It is a native of stony places exposed to the sun, in the South of Europe by the sea-side, such as Portugal, Spain, Greece, Piedmont, Mauritania, &c. (*Cheiranthus tristis*, Lin., Spec., 925. *Hesperis angustifolia*, Lam., Dict., iii., p. 322 ; Barrelier, Icon., Plantæ per Gallium, Hispanium et Italiam observatæ, t. 803.

M. annua is the original of all the varieties of Ten-week Stock. It is a native of the South of Europe by the sea-side. (Sweet, Hort. Suburb. Lond., 147. *Cheiranthus incanus*, Lin., Spec., 925. Schkuhr, Botanisches Handbüch, ii., t. 284 : Bauhin, Historia Plantarum, ii., p. 875, f. 1. *Matthiola incana, var. δ*, R. Brown, in Ait., Hort. Kew, ed. 2, iv., p. 119. *Hesperis Sativa, var. a*, Lam., Dict., iii., p. 324.

M. Græca. (Sweet, Hort. Suburb. Lond., 147). The smooth-leaved Annual or Grecian Stock is a native of Greece and the neighbouring islands. It is distinguished from *M. annua* in the leaves being smooth and green, not hoary. Its flowers are purple. *Cheiranthus Græcus*, Jussieu, in Pers. Ench., ii., p. 201. *Hesperis æstiva, var. β*, Lam., Dic., iii., p. 324.

M. sinuata. (R. Brown, in Ait., Hort., Kew., ed. 2, iv., p. 120). The "Great Sea Stock" is an herbaceous plant of 2 feet in height, with an erect, branched stem. Leaves oblong and downy, the lower ones sinuated; siliques compressed velvety and muricated with glands. Flowers of a dingy-red colour, about the size of *M. incana*, sweet-scented in the evening. The whole plant has an alkaline bitterish taste. Native of the South of Europe, along the sandy sea-coast, also of Britain on the coasts of Cornwall and Wales, near Pembroke, Abermeney and Llanddwyn. (*Cheiranthus sinuatus*, Lin., Spec., 926; Smith, Eng. Bot., t. 462; Smith, Flor. Græc., t. 640; *C. tricuspidatus*, Hudson, Flora Anglica, ed. 1, p. 450; *C. muricatus*, la Marck, Flore Française, ii., p. 507; *Hesperis sinuata*, Lam., Dic., iii., p. 323.

M. simplicicaulis, Sweet, Hort. Brit., p. 17. This is the parent plant of the "Brompton Stock." It differs from *Matthiola incana*, or "Queen Stock" (to which it was formerly attached as a simple variety), in the plant being a biennial, not shrubby; it is simple, not branched.

M. odoratissima, R. Brown, in Ait., Hort. Kew., Ed. 2, iv., p. 120. This is a shrub with an erect stem of 1 to 2 feet in height; branched; leaves downy or pubescent, toothed or pinnatifid; siliques compressed, somewhat hoary. Flowers very large, dirty cream-coloured, or when old purplish-brown, sweet-scented in the evening. It is a native of the calcareous mountains of Tauria, and on rocks in Eastern Caucasus, also in Iberia, about Tiflis. Bot. Mag., t. 1711. *Hesperis odoratissima*, Poiret, Suppl., iii., p. 195. *Cheiranthus odoratissimus*, Bieberstein. This plant is found in Western Thibet, in dry, stony places on the mountains, ascending to 12,000 feet.

> *Var. β, Tanaicensis* (D.C., Syst., ii., p. 170). This variety is covered with appressed pubescence; siliques one half shorter than those of the species. It is a native on the cretaceous hills at Tanaim. *Cheiranthus fragrans*, Fischer, in Catalogue du jardin des plantes de Gorenki, 1812, p. 51.

The method of culture recommended to procure fine double Stocks is to make choice of such single-flowering plants as grow near many double ones, for it has been observed that seed saved

from plants growing among double kinds have produced a much greater number of double-flowering plants than those which have been saved from plants separated from the double ones. Sow the seed early in May, and when the seedlings reach 2 or 3 inches in height, they should be thinned out so as to leave them 9 inches apart. The plants so taken out can be bedded elsewhere in the same way. Fine double varieties may be propagated by cuttings, which root readily if planted under a hand-glass and shaded. The large varieties of Stocks present a peculiar anomaly in their flowering: those which are sown from April to July do not flower in the order of their sowing, those sown in July always flowering before those sown three months earlier.

One of the most beautiful varieties of Stock is the "Purple Cocardeau." It may be sown during the latter half of the year, so as to flower the season following. These, when carefully cultivated, yield from 45 to 55 per cent. of double flowers. The colours of the different varieties of the "Cocardeau" are red, first grown at Compiègne in the beginning of the century, and introduced into Paris about 1822; white, first grown in Paris in 1833; violet, first grown in Paris in 1845; the bright carmine, first grown at Erfurt in 1854; and a bronze crimson (known as the Louise Léon) first grown by Benary, a seed-grower at Erfurt, in 1859. Double flowers are produced by pinching off part of the seed vessels, good results being obtained when as much as 75 per cent. is pinched off. Seeds should be sown from April to July for flowering in the May and June of the following year. With double-flowering Stocks, when the first set of flowers has been gathered, another makes its appearance, so that the time of flowering is greatly extended.

The "Pyramidal Stock" is an exceedingly beautiful variety, often growing to the height of over 3 feet. The branches are crowded with bloom, and four or five flowering branchlets surround the base of each spike. It is more double than the preceding variety, and by pinching off the seed vessel may be made to yield 40 per cent. of doubles. Seeds of it should be sown in April and July to flower the following year. The colours are carmine-red, crimson, white, deep violet, light violet, pale pink, flesh colour, brick-red, bronzed nankeen and chamois.

Large "Tree Stocks" are the oldest of all the varieties of Stocks.

The branches are slender and the flowers smaller than those of the other kinds. They yield 60 per cent of double flowers, and are obtainable in 25 different colours.

"Intermediate" Stocks are considered the most beautiful of all the Stocks, uniting, as they do, all the good qualities of the others. They bloom early and abundantly, keep a long time in flower, and bloom for two years in succession; the flowers are large and their colours very brilliant. They grow easily from seed, and yield double kinds in the proportion of 70 or 80 per cent.

"Ten-week" Stocks. This Greek variety, as above mentioned, has shining green foliage. They should be treated the same as the Cocardeau Stock. They flower abundantly, and are of various colours. One of them is yellow, and is the only instance of this colour occurring among Stocks. Singularly enough, the single flowers, the seeds from which produce the yellow double variety, are always white; but if the seedling plants of this variety be not grown apart from other varieties which are white, they are apt to go back to their primitive colour, which is white. There are also crimson, pink, violet and buff varieties, but they yield but few double kinds. A new variety with white flowers, called the "White Greek Cocardeau," has been introduced. This belongs to the sort called "Perpetual Emperors," and bears long spikes densely crowded with white blossom, the base being surrounded by a ring of small flowers. It closely resembles the "Giant Cocardeau," and holds one of the highest places amongst this beautiful tribe. It yields about the same proportion of double sorts as the first three varieties. The Greek Stocks are a little more tender than the other sorts.

Perpetual Autumn and Winter Ten-week Stocks. These were first obtained by the Erfurt seedsmen by crossing the Pyramidal variety with the Perpetual Emperor. Sown in heat in February, and pricked out into a frame, they produce large masses of bloom from October to January. Flowering as it does so late in the season, this variety is very useful. It includes eight different kinds, which yield from 50 to 70 per cent. of double forms, according to the method in which it is grown. It is most important to keep the secondary shoots well pinched down, as this variety has a tendency to return to the primitive type. The

principal varieties of this class are carmine, bright carmine, white, chamois, brick-red, light pink, dark violet and sky blue.

"Annual Ten-week Stock." This variety may be divided into seven different kinds, each of which gives rise to sub-varieties. They should be sown for succession from the month of February onwards. Sown in heat, and pricked out under a warm frame, they may be transplanted out of doors as soon as they are old enough, and will bloom throughout May and June. For June and July flowering, they should be sown in heat in March, and pricked out into a cold frame. Sown in a cold frame in April and May, and pricked out at once into the open ground, they will flower in August. Sown in August, September and October like Perpetuals, and protected through the winter, they will bloom in March, April and May; so that by proper management they may be had in bloom during the greater part of the year.

"Large Flowered Ten-week Stock." This is considered to be the finest of all the Ten-week Stocks. Its flowers are very large, and closely resemble the large kinds of Cocardeau. They yield about 75 per cent. of double varieties under careful management. There are more than 20 different sorts, but the following are the most distinct in colour: "Extra Crimson" (first grown by Benary, of Erfurt, in 1861), pearly-white, whitish-violet, carmine, pure white, Parma violet, flesh-coloured, cinnamon, light brick, purplish-pink and bronzed yellow.

"Greek Ten-week Stocks." These are sown out of doors, and not transplanted. They only produce one spike of bloom. By sowing for succession from February to the end of June, they will flower through the greater part of the year, but they are rather delicate, and likely to be killed by frost.

The "Erfurt Ten-week Stocks." This is the ordinary English Ten-week Stock raised in Germany. The general appearance of the plants is bushy, their comparatively short shoots being covered with compact masses of bloom. By adopting the plan of sowing for succession, they may be had in bloom nearly the whole of the year. They may be made to produce 75 to 80 per cent. of double kinds. There are more than 25 different varieties. The following are the most distinct: snow-white, light blue, bright carmine, crimson, ashy grey, pale violet, nankeen, brick red, dark purple, bronze and black.

"French Ten-week Stocks." The flowers of these are small, their shoots are thin, and they have long been superseded by the sorts above described. They are hardly worth cultivating.

"Dwarf Ten-week Stocks" are grown for ornamental purposes. They produce numberless little shoots covered with compact masses of bloom.

"Pyramidal Ten-week Stocks" have very long flower-stalks. They should be sown in March and July for summer and autumn flowering, and should never be kept through the winter, for during the cold weather they are apt to grow weakly and produce worthless flowers.

"Lavender-leaved Ten-week Stocks" furnish fine spikes, thickly covered with beautiful flowers; but their foliage is liable to be attacked by mildew, and they are but little grown.

Hesperis.

Hesperis. The "Rocket"; a genus of *Cruciferæ* belonging to the section having the radicle of the seed bent over the back of one of the flat cotyledons. They are biennial or annual (rarely perennial) herbs with somewhat the habit of the Stock, but usually with less stellate pubescence. The generic name *Hesperis* is derived from ἑσπερος, the evening, because most of the species of one section of the genus (*Hesperidum*) are sweet scented only in the evening and at night, never throughout the day-time (D.C., Syst., ii., p. 447, and Prodr., i., 188); such flowers are of a dark, dreary colour. The most noticeable in this section, as regards fragrance, are *H. tristis* and *H. fragrans*:—

H. tristis (Lin. Spec., 927). Native of Austria, Hungary, Transylvania, Tauria, South of Russia, and of Naples, about the edges of fields and woods. It is from 1 to 2 feet in height, much branched at the top, sometimes almost smooth, sometimes more or less hispid, with long, spreading hairs. The radicle leaves are stalked, upper ones sessile, ovate, acute, entire or grossly-toothed, smooth or pubescent, 2 to 4 inches long; hairs short, somewhat glandular. Flowers of a dirty-white or cream-colour, brownish-red or dirty dark-purple. Pedicels very long, spreading, rigid, equalling the pod in breadth; pods two-edged, thickened on the margin;

petals oblong, oblique. Bot. Mag., t. 730; Jacquin, Floræ Austriacæ Icones, ii., p. 1, t. 102; Schkuhr, Botaniches Handbüch, ii., t. 184. This plant seems to be identical with *Cheiranthus lanceolatus,* Willd., Spec., iii., p. 515.

H. fragrans, Fischer, in Sweet's British Flower Garden, t. 61. Native of Siberia. The height of this plant is about 9 inches. Its lower leaves are stalked, lanceolate, runicate, bluntish, upper leaves sessile, ovate, acuminated, coarsely-toothed at the base. Flowers purplish.

The other section of *Hesperis* is known as *Deilosma,* from δειλη, the day, and οσμη, a smell. The flowers of the plants belonging to this section smell in the day-time as well as at night (D.C., Syst., ii., p. 448, and Prodr., i., p. 188. The most commonly known species is *H. matronalis* (Lam. Dict., iii., p. 321, and Ill., t. 564, f. 1). This is the common garden Rocket, a very variable plant of from 1 to 4 feet in height. Many of its varieties are in cultivation. It is a native of coppices and hedges nearly throughout the whole of Europe, but is probably not indigenous to Britain. The pedicels are the length of the calyx; petals obovate, pods erect, torose, smooth, not thickened at the edge; leaves ovate-lanceolate, toothed. Of this species there are several varieties, both single and double, and in numerous colours.

H. Grandiflora, Bot. Mag., t. 2683, is a fine plant of 3 feet in height; probably a native of Hungary. There are numerous other well-marked species and varieties, but of less importance as regards their perfume.

The perennial species of this genus thrive best in a light rich soil, but they require to be frequently transplanted and divided, otherwise they will not long exist, particularly the double varieties of *H. matronalis;* the best time to do this is after they have flowered and when again beginning to spring afresh from the root: also if the flower stems are well cut down before they are much exhausted by the bloom, a good stock of off-sets will be produced.

The biennial and annual sorts do well in any common garden soil, requiring the same treatment as other hardy annuals and biennials.

Murraya.

Murraya. A genus of *Aurantiaceæ*, native of India, Java, China, &c., consisting of trees or shrubs, without spines, having pinnate leaves, and a terminal many-flowered cymose inflorescence. The flowers have a 5-cleft calyx, oblong petals, ten free stamens, and one or two ovules. The fruit is succulent.

M. Exotica (Bot. Reg., t. 434; Lam. Ill., t. 352. Syn. *Chalcas Japonensis*, Lour. Coch., p. 271. *Marsana buxifolia*, Sonnerat, Voyages aux Indes Orientales et à la Chine, t. 139. Rumph. Amb., v., p. 29, t. 18, f. 2). The "Chinese Box Tree." This species appears to be a great favorite with the Chinese, whence it is known among the French in the Isle of France by the name of "Buis de Chine." It is known to have been brought many years ago from China to the Coast of Coromandel, where it has continued to be universally cultivated in the gardens ever since. It has likewise been found, not unfrequently, in the wild state among the mountains of the Northern Circars. In the East Indies, according to Roxburgh, this species, when in the wild state, is generally seen in the state of a large bushy shrub, sometimes as a small tree of 10 feet in height with a pale cinereous bark. Leaves scattered, pinnate with an odd one; leaflets generally in 3 pairs, alternate, obovate-oblong, emarginate, smooth, of a deep shining green, 1½-2 inches long, about 1 broad, lowermost smallest: petioles glandular, round. Corymbs terminal, crowded, with rather large, beautifully and purely white, exquisitely fragrant flowers. Calyx 1-leaved, 5-cleft, glandular, segments erect, pointed; anthers oblong: germen glandular, 2-celled with 2 ovules in each cell vertically attached to the uppermost part of the partition. Berry superior, 2-celled, seeds solitary, 1-2, oblong, pointed above, flat on one side, woolly; embryo inverted, albumenless. The fruit is about the size of a largish pea, has a leathery rind, beset with small miliary glands like that of an orange. This species is cultivated in England as a stove-plant on account of the fine fragrance of its opaque, snow-white blossoms and their pleasing contrast to the deep green of the foliage.

M. Paniculata. (Hooker's Exotic Flora, t. 79. Jack, Malayan, Miscellany, i., No. 2, p. 31. Syn. *Chalcas peniculata*, Lour. Coch.

p. 270; Rumph. Amb., v., p. 26, t. 17). Native of East Indies; leaves ovate, accuminated: flowers terminal and axillary, usually panicled; berries oblong, usually 2-seeded. Flowers white, with the scent of jasmine. The fruit is red, about the size of a small capsicum, and has a strong scent like the gooseberry. This tree attains a height of 20 feet.

Solvent Power of Essential Oils.

According to recent researches of Dr. Georg Bornemann ("Technischen Mittheilungen für Malerei," pub. by A. Keim, Munich), the following table exhibits the solubility of certain gums in essential oils :—

100 parts by weight of	Dissolve parts by weight of						
	Amber.	Colophonium.	Copal.	Damar.	Mastic.	Shellac.	Yellow Bees' Wax.
Oil of Camphor (light) ...	9·73	46·16	9·16	34·95	35·04	1·33	
„ „ (heavy)	6·50	31·35	2·81	50·08	37·93	0·83	
„ Cajeput	6·53	43·70	5·52	42·49	41·16	0·66	
„ Copaiba		24·95	0·00	34·57			4·49
„ Lavender... ...		52·86		33·07			9·34
„ Clove		79·79	0·00	18·27			
„ Rosemary ...	10·16	48·94	4·81	99·44	21·39	0·79	
„ Spike Lavender ...	8·90	40·98	9·51	41·66	33·47	3·67	
„ Turpentine ...	7·47	51·84		64·28	52·79	12·94	
„ „ rect. ...	10·30		6·47				8·10
„ Paraffin				9·27			4·46

Approximate comparison of some English & Foreign Weights and Measures.

1 centimètre	=	0·39371 inch.
1 inch	„	2·539954 centimètres.
1 mètre	„	39·37079 inches.
„	„	3·2808992 feet.
„	„	1·0936331 yard.
1 foot	„	0·30479449 mètre.
1 yard	„	0·91438348 „
1 cubic centimètre (or millilitre)	„	0·061027 cubic inch.
1 cubic inch	„	16·3861759 cubic centimètres
1 litre (or cubic decimètre) ...	„	61·027052 cubic inches.
„ „ „ ...	„	0·220097 gallon.
1 gallon	„	4·543457969 litres.
1 ton	„	1016·0475360 kilogrammes.
1 cwt.	„	50·8023768 „
1 pound	„	0·45359265 „
1 kilogramme	„	2·2046213 pounds.
1 gramme	„	15·432349 grains.
1 grain...	„	0·064798950 gramme.
1 Picul	„	133½ pounds.

Equivalents of grammes in grains—

GRAMMES.	GRAINS.	GRAMMES.	GRAINS.	GRAMMES.	GRAINS.
1	= 15·432349	4	= 61·729396	7	= 108·026443
2	= 30·864698	5	= 77·161745	8	= 123·458792
3	= 46·297047	6	= 92·594094	9	= 138·891141

Equivalents of grains in grammes—

GRAINS.	GRAMMES.	GRAINS.	GRAMMES.	GRAINS.	GRAMMES.
1	= 0·064799	4	= 0·259196	7	= 0·453593
2	= 0·129598	5	= 0·323995	8	= 0·518392
3	= 0 194397	6	= 0·388794	9	= 0·583191

From these tables grains and fractions of grains may be converted into their equivalent in grammes, or *vice versâ*, by a simple addition, after removal of the decimal point to left or right, as required, *e.g.*: 5·31 grammes = 77·161745   4·629704 + ·154323 = 81·945772 grains.

Temperature—

To convert F. to C. ... $\frac{F - 32 \times 5}{9} = C.$

To convert C. to F. ... $\frac{C \times 9}{5} + 32 = F.$

ANALYTICAL INDEX.

CORRIGENDA.

Vol I.

Page 19—*Eurybia argophylla* is by mistake confused with *Guarea Swartzii* in the same paragraph. This is corrected and re-written in Vol. II., p. 403.
,, 78, line 7—For *Havenia* read *Hovenia.*
,, 110, ,, 1— ,, *Auclandia* read *Aucklandia.*
,, 125, ,, 24— ,, protocatechuic *acid* read protocatechuic *aldehyde.*
,, 134, ,, 23—Cancel the word *Anethum.*
,, 189, ,, 27—For *Oxycantha* read *Oxyacantha.*
,, 234, ,, 38— ,, *trees* read *tears.*
,, 342, ,, 12— ,, 24° read 29°.
,, 46, ,, 19—The word "Coker-nut" occurs. The author is certainly not the patentee of such an ugly word. The largest fruit importers and dealers in London spell it in that way in their Catalogues and Lists. However, as people outside the Fruit Trade find the spelling to be "barbarously phonetic," it is discontinued, and the usual inappropriate word "Cocoa-nut" adopted.

Vol. II.

In List of Works referred to—For Alfzelius read Afzelius.
Page 8, line 6—For diæcious read diœcious.
,, 12, ,, 18— ,, monæcious ,, monœcious.
,, 12, ,, 18— ,, diæcious ,, diœcious.
,, 13, ,, 13— ,, monæcious ,, monœcious.
,, 86, foot-note, line 1—For Zangiber read Zingiber.
,, 92—The paragraph commencing line 25 should have been placed after line 13.
,, 117, line 4—For Salica read Silica.
,, 119, ,, 14— ,, *Elattaria* read *Elettaria.*
,, 119, ,, 34—Cancel the words "Bengal and."
,, 127, ,, 26—For *salivum* read *sativum.*
,, 144, ,, 12— ,, *serpillum* ,, *serpyllum.*
,, 144, ,, 17— ,, ,, ,, ,,
,, 404, ,, 15— ,, Observations Botanicæ read Observationes Botanicæ.
,, 488, ,, 24—Cancel comma at end of line.
,, 488, ,, 25—For "and" read *et.*

The word *bracteas* (small floral leaves placed immediately below a calyx on the peduncle or pedicel), has in nearly every case been spelt *bractes*, a method which was used by Dr. Roxburgh and other authorities, but now out of fashion, the *e* being omitted. The variance with the modern custom was not noticed until the work was too far advanced in press to alter it, but in point of fact *bractes* is as correct as *bracts*, and neither mode is as correct as *bracteas.*

When a writer undertakes, single-handed, a great number of subjects, some errors, typographical or otherwise, are nearly sure to be made.

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